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for the year

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INTRODUCTION

It is an unusual pleasure to record that the staff position improved during the year and it was possible to undertake more experimental work. All posts have not yet been filled and a Plant Breeder and Chemist for the Lilongwe Agricultural Research Station are still awaited. This Station harvested the first crops during the year and progress was made towards the establishment of Experimental Stations at Tuchila in the Southern Province and Mbawa in the Northern Province. The Experimental Stations now in being in the Protectorate are as follows :

	Principal Crops or Work in Progress
Southern Province	
Tea Station, Mlanje	Tea
Tung Station, Cholo	Tung
Tuchila, Palombe	Dark-fired tobacco, maize, etc.
Makanga, Chiromo	Cotton and food crops
Central Province	
Agricultural Research Station, Lilongwe	Dark-fired and air-cured tobacco, hybrid maize, etc.
Lisasadzi, Kasungu	Flue-cured tobacco
Mwera Hill, Dowa	Fruit trees
(E.C.G.C. Chitala)	Cotton.
Northern Province	
Mbawa, Mzimba	African agriculture
Nchenachena	Coffee.

The above Table gives a list of the principal crops on which work is being undertaken, but other problems, especially fertility problems, are being investigated on all these stations. Livestock is kept at all stations and in this connection close liaison is maintained with the Veterinary Department. Observational trials of various grasses for resting leys and permanent pasture are conducted at all stations, the work being under the general direction of the Ecologist. In addition to these stations there are plots of land at the headquarters of the Agricultural Officers where small experiments may be carried out.

The Entomologist, Pathologist and Agricultural Chemist are stationed at Zomba and the Ecologist at the Lilongwe Agricultural Research Station.

TEA EXPERIMENTAL STATION

Tea Research Officer in Charge .. .. C. R. Harler
Field Officer .. .. D. H. Laycock
Field Officer .. .. R. B. Royle

(*Received* 31–1–1951)

Swazi and Mimosa Estates

1. The Tea Experimental Station consists of two distinct areas, Swazi near Ruo Estate, and Mimosa about six miles away, adjacent to Thornwood Estate.

The area of Swazi is about 70 acres, of which 32¼ acres are reckoned to be under mature tea. The rest of the area consists of tea and citrus nurseries, blue-gum clearing, buildings, lines, etc.

Of the 32¼ acres of tea at Swazi, 13 acres have been under statistical experiment for some years. During 1950 another 4¼ acres have been put under experiment.

The yield from Swazi over the past ten years is shown below :

TABLE 1

Year	*Area mature tea acres*	*Crop green leaf 1,000 lbs.*	*Yield tea per acre lbs.*
1941	28½	116	916
1942	28½	139	1,098
1943	28½	146	1,153
1944	28½	136	1,074
1945	28½	144	1,137
1946	28½	163	1,287
1947	28½	178	1,390
1948	28½	162	1,279
1949	30½	101	745
1950	32¼	175	1,220

The yields per acre have fallen off slightly in recent years and it is possible that 35–40 lbs. nitrogen per acre in the form of sulphate of ammonia (which has been the annual dressing for some years) is not enough to maintain fertility. In November the dressing was increased to 80 lbs. nitrogen per acre and this rate will be maintained in future.

The Mimosa Estate comprises 683 acres. This planting season 50 acres of tea have been put out in accordance with the programme of experiments laid down and a further 50 acres already felled is now being cleared.

The work on leaf-cuttings from selected bushes from three estates in the Cholo District and two in Mlanje has been begun. The clone nursery is at Swazi but the clones will be put out at Mimosa.

Experiments at Swazi

Bringing Young Tea into Bearing :

2. This experiment has been concluded and the results published in full in the *Nyasaland Agricultural Quarterly Journal Vol. 9, No. 1, 1950.*

Six of the more common methods used in Nyasaland to bring up young tea were compared in a 6×6 latin-square. The tea, of Indian variety, was planted as stumps in December, 1942, and the treatments applied until 1950.

The best commercial way to bring young tea into bearing is to cut across at about 16 ins. at 18 months after planting in the field, followed by plucking at about 27 ins. The best possible way is to pluck the young plant from the beginning so as to form a good bush, but this way is perhaps beyond estate use with the present plucking standards shown by labour.

Whatever initial treatment is used the mature bush yields about the same, but crop can definitely be lost during the immature years by not adopting a good treatment initially.

Spacing of Tea

3. This experiment is designed to test the effect on yield of various spacings of the tea bush in the field. The experiment was laid down in 1941 in randomized blocks. Four spacings are compared and the yields for the past season are given below in lbs. of made tea per acre. It must be remembered that the tea is now mature and is giving a complete cover at all spacings.

TABLE 2

Spacing	3½ft.×3½ft.	4ft.×4ft.	4½ft×4½ft.	5ft.×5ft.	Sig. Diff. P=0.05
Bushes per acre	3,600	2,760	2,200	1,760	
Yield per acre	2,352	2,233	2,143	1,929	299

The two closest spacings have given a significantly higher yield than the widest spacing. No significant difference exists between these two closest spacings themselves or between them and the 4½ ft. square spacing.

The yield figures ascend in fairly regular order inversely as the width of spacing, approximately 100 lbs. of tea being added for each 6 ins. reduction in spacing distance.

Different Methods of Pruning and Extending the Pruning Cycle

4. The results of this experiment over the past nine years have been analysed and published in full in the *Nyasaland Agriculture Quarterly Journal, Vol. 9, Part 3.*

Six treatments are involved as listed below :

Method	*Frequency*
Cut-across prune	Yearly
Clean-prune	Yearly
Cut-across with cleaning out of the centre of the bush	Yearly
Cut-across prune	Every second year
Clean-prune	Every second year
Clean-prune	Every third year

Over the nine-year period the highest aggregate yield was given by the two-year clean-prune cycle which was significantly better than any of the cut-across treatments and the annual clean-prune. It was not significantly better than the three-year clean-prune cycle.

In the early years when soil fertility was high, the cut-across treatments were superior, but as time went on and soil fertility dropped the clean-pruned treatments took the lead and gained an actual position of yielding more in aggregate than the cut-across treatments.

It is reasoned that soil nutrient status is not being maintained at the optimum level by the fertilizer mixture used, which gives 35 lbs. nitrogen, 24 lbs. phosphate and 12 lbs. potash per acre.

The lengthening of the pruning cycle produces a better developed bush frame.

The recommendations made from these results are that at least a two-year pruning cycle should be used and that where nitrogen is being added at the rate of 60 to 80 lbs. per acre a three-year cycle is suggested. Until further evidence is available the more expensive clean-prune should be used in preference to a cut-across prune.

The experiment is being continued and the fertilizer rate has been increased to 80 lbs. of nitrogen.

Weeding Experiment

5. The practice of " forking " tea land has been abandoned by most estates in Nyasaland. The main cultivations now practised in mature tea are towards the control of weeds. The experiment has been in progress at the station for nine years comparing some of the more common methods of weed control. Seven treatments are compared :—

(1) Hand weeding and the weeds-left to rot on the surface.

(2) Weeds slashed with a knife and left on the surface.

(3) Weeds hoed out and removed.

(4) Weeds hoed and lightly buried with soil.

(5) Weeds hoed and left on surface.

(6) No weeding but weeds broken back to below the plucking surface.

(7) Weed suppression by the growth of a leguminous cover crop of *Desmodium sp.* and *Indigofera sp.* with hand weeding and removal of weeds if necessary during the establishment of the cover crop.

Yields in lbs. made tea per acre for the past season are as follows :—

TABLE 3

Treatment ..	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Sig. Diff.
Yield	1,312	1,236	1,480	1,403	1,182	1,299	1,303	None

For the last five years of this experiment no significant differences have been shown. In earlier years there were significant differences, but these were inconsistent and have not shown any treatment to be consistently better than any other.

The idea of weed suppression, therefore, should be investigated, not from the viewpoint of the number of hoes needed, but rather with the idea of encouraging cultural practices designed to ensure that a rapid and continued soil cover is provided by the bush. To use the bush to suppress weeds is killing two birds with one stone. Weeds are kept down to a minimum and, because of the increased spread of the bush, higher yields may be expected. Weeds should always be broken back below the plucking table otherwise they interfere with the process of plucking, and crop will then be lost as a result of bad plucking.

This experiment has now terminated and the area will be put under a manurial trial with N/P/K.

Time of Application of Fertilizer to Tea

6. The object of this experiment is to record differences, if any, shown by applying fertilizer to tea at different times. Four times of application are compared.

(1) Whole dressing in the first week of November, a time normally just before the start of the rains.

(2) Whole dressing applied during the first week of January when the crop is in full flush.

(3) Half during the first week in November and half during the first week of January.

(4) Half during the first week of November and half in the first week of March, towards the end of the rains.

Results for the past season are set out below in lbs. made tea per acre :

TABLE 4

Treatment	(1)	(2)	(3)	(4)	Sig. Diff.
Yield	1,811	1,807	1,718	1,723	none

Fertilizer was applied at the rate of 35 lbs. nitrogen per acre and this dose has had little effect on crop no matter what time it is applied. This result is in conformity with the previous years' results.

Effect of Grass and Weeds on Tea

7. An experiment was laid down in 1947 to compare the effects of grasses and weeds on tea. Six treatments are compared :—

(1) All natural weeds and grasses allowed to remain.

(2) Natural grasses only allowed to remain.

(3) Natural weeds only allowed to remain.

(4) Seychelles grass *(Panicum umbilatum)* deliberately planted.

(5) Dhub grass (*Cynodon sp.*) deliberately planted.

(6) Clean weed.

Treatments (2) and (3) are mainly of academic interest. Seychelles and dhub grass, because of their creeping habit are good grasses for erosion control. But if used as such near tea there is every chance that they will encroach into the tea. This has in fact happened in certain parts of Swazi. These two grasses were included, therefore, to see what effect they have on tea.

The tea was pruned in 1948 and the treatments established. The 1949–50 results are recorded below in lbs. made tea per acre :—

TABLE 5

Treatment	(1)	(2)	(3)	(4)	(5)	(6)	Sig. Diff.
Yield	1,050	1,049	975	780	1,016	1,164	196

Seychelles grass has, therefore, significantly reduced the crop and all other treatments give less than the clean-weeded plots but not significantly so.

Except for Seychelles grass, the same arguments apply as those used in the cultivation experiment above, namely, that a good and rapid spread of bush in itself reduces weed growth to a minimum and thereby such weed growth as there is does not seriously affect yields. In the case of Seychelles grass, however, a very different picture pertains. This grass appears to thrive under shade and is so vigorous that it forms a thick mat which is extremely deleterious to the growth of the tea bush. The Seychelles grass plots are of an unhealthy yellowish colour suggesting thereby that the tea is lacking nitrogen.

At this stage of the experiment the advice to be offered is that Seychelles grass should not be planted in any place where there is the slightest chance of its encroaching into the tea.

TUNG EXPERIMENTAL STATION

Agricultural Officer in charge : J. A. Sandys

Tung Chemist : C. V. Cutting.

(*Received* 9–2–1951)

8. As little repetitive reference as possible is made in this Report to the labour difficulties encountered here during the year. The number of men required for field work varies from about 30 to 50 according to the time of year, and the force fell steadily between July and October from an average of 30 to an average of nine. It remained at about that figure to the end of the year. The position was complicated by the need to divert labour who could otherwise have been doing field work, to helping builders. As a result much experimental work has either been left undone or been done less well than it should have been, and practically no new work has been started.

Production of Improved Planting Material

Selection of Promising Mother Trees

9. Apart from the recording of special trees on the Station no new seedling trees have been surveyed this year. Promising trees on estates have been recorded for several years but the different conditions of cultivation and manuring from one estate to another make it difficult to compare their respective values. Buddings have been made of 22 of the best seedlings from estates and the Tung Experimental Station and placed in randomized blocks in order to obtain a proper comparison.

Buddings versus Seedlings

10. One of the first experiments started at the Station was designed to compare (*a*) open-pollinated seedlings, (*b*) seedlings from four selected, high-yielding mother trees, (*c*) buddings from the same mother trees on *Aleurites fordii* stock and (*d*) buddings from the same trees on *A. montana* stock. The results have shown consistently, until this year, that the buddings on *A. montana* stock were significantly greater (P=0.01) than any of the other treatments. In 1950 it was still greater than selected and unselected seedlings at the 1 per cent. level, but just failed to be better than those on *A. fordii* stock (P=0.02). *A. fordii* stock was better than unselected seedlings (P=0.01). The lower degree of significance of *A. montana* over *A. fordii* stock is surprising and the reason is not clear. However, it has frequently been noticed that *A. fordii* withstands adverse conditions much better than *A. montana*, and it is possible that this capacity enabled the buddings on *A. fordii* to weather the drought of 1948–1949 better than those on *A. montana*.

TABLE 6

YIELDS IN LBS. AIR-DRY SEED PER TREE

	Clones				
Treatment	M8	M13	H14	F9	Means
Montana Stock	50.0	50.4	42.7	31.8	43.7
Fordii Stock	27.5	36.9	34.8	34.9	33.5
Selected Seedlings	39.7	24.1	19.8	17.7	25.3
Unselected Seedlings ..	—	—	—	—	20.3
Means	39.1	37.1	32.4	28.1	

SIGNIFICANT DIFFERENCES

P=	*Between buddings*	*Between Clones*
0.05	8.89	7.45
0.02	10.85	8.98
0.01	12.29	9.94

Clone Trials

11. The differences in yields between clones in 1950 in the above experiment shows only M8 and M13 greater than F9 at the 1 per cent. and 2 per cent. levels respectively, whereas in 1949, M8, M13 and H14 were all greater than F9 at the 1 per cent. level. It was pointed out in last year's Report that the superiority of M8 seedlings in this experiment is due to the fortuitously large number of bearer trees. These are included in the analysis of the clones as a whole and, therefore, contribute to the superiority of M8 for all treatments. But it is interesting to note that budded trees of M8 of the same age in another experiment, described in paragraph 15 below, have also shown a sudden acceleration in increases of yield as compared with other clones, one of which is F9. Two of the other clones in this latter experiment, 10 and 14, are vigorous B-types* and until this year had given consistently the highest yields. For the first time M8 has out-yielded both, (though not at statistically significant levels) as well as F9 at the 2 per cent. level. M8, being an A-type, is slower developing than 10 or 14, but it is surprising to find it giving quite such high yields at this stage. The yields for this clone, are almost identical in these two experiments, 50.0 and 50.1 lbs. air-dry seed per tree. This is only a fraction below M13, 50.4 lbs. per tree, a clone which has long been a reliable and heavy bearer. It seems as if 10 and 14 may be approaching their peaks of production since their yield curves are flattening out as compared with M8 and another A-type, N24, which is included in the same experiment and whose yield curve has climbed sharply this year.

A summary is given below of the yields at comparable ages, of nine of the most promising clones in replicated trials.

*Type "A" clone makes trees in which the main trunk increases steadily in height and carries tiers of primary branches one above the other at some distance apart. Secondaries arise on primary branches at relatively long intervals. They are, however, readily distinguished from the B-type clones in which the main trunk usually ceases to exist after producing the first or second (rarely third) whorl of primary branches, and which produce secondaries at short intervals, resulting in low, dense, bushy trees.

TABLE 7

YIELDS OF THE NINE MOST PROMISING CLONES IN LBS.

AIR-DRY SEED

Age years		3		4		5		6		7		8		9	
Clone	Type	per tree	per acre	per tree	per acre	per tree	per acre	per tree	per acre	per tree	per acre	per tree	per acre	per tree	per acre
ZM8 ..	A	1.8	100	6.1	342	9.8	549	14.8	829	23.6	1,322	29.1	1,630	50.0	2,800
ZM13 ..	A	1.9	106	9.3	521	11.2	627	16.9	946	26.9	1,506	31.8	1,781	50.4	2,822
ZM14 ..	B	7.7	431	13.9	778	23.5	1,316	21.3	1,193	27.9	1,562	32.6	1,826	42.3	2,369
ZM10 ..	B	7.6	426	13.3	745	27.6	1,546	22.7	1,271	28.5	1,596	36.4	2,038	42.9	2,402
ZO4 ..	B	12.0	672	20.5	1,148	30.1	1,686	25.7	1,439	35.0	1,960				
E460 ..	B	5.5	308	19.9	1,114	28.6	1,601	32.9	1,842						
E464 ..	B	10.4	582	17.0	952	32.9	1,842	36.8	2,061						
ZN4 ..	B	3.9		4.5		5.3		4.8		8.7		9.1			
B741 ..	A	4.7	263	16.6	930	21.3	1,193	19.0	1,064	29.5	1,652				

It is impossible to select one or other of these clones as the best, as their performances vary so much according to cultural methods, and there is no replicated trial which contains them all. It has been noticed that lack of cultivation and nitrogenous fertilizing has led, on at least one estate, to distinct biennial bearing. This could probably be corrected by proper treatment to give uniformly high yields each year.

Breeding new lines

12. A comprehensive policy of breeding to raise lines which would come true to type from seed is out of the question because of the time, land and money involved. However, 650 individuals of controlled pollinated A-type seedling families which were planted out in January, 1945, have borne their second crop this year. There are several which appear promising but their yields must be recorded for another year or two before it will be worth trying them as budding material.

A further 1,300 individuals have been grown this year from seed produced by controlled pollination of selected B-type clones. Lack of labour has prevented their removal from the nursery.

Cultivation and Manurial Experiments

Intercropping and Cover Crops

13. There is one experiment at the Station which compares inter-cropping tung with :

(*a*) Soya Beans every year

(*b*) Maize and a legume in alternate years

(*c*) Permanent cover crop of *Glycine javanica*

(*d*) Tumble-down grass and weed cover, slashed twice a year, the grass being collected and mulched round the trees with 1 lb. sulphate of ammonia each time.

The trees in this experiment were planted in January, 1945, and bore their second crop this year. They have not yet settled down to steady bearing.

It has been noticed that the vegetation on the grass plots provides a poor cover, being tufted and having comparatively large spaces of bare earth between. The soil in these interspaces is packed hard, and from its colour, appears to have a much lower content of organic matter than the plots of the other three treatments. The condition looks very similar to that of overcropped land. The *Glycine javanica* adds considerable quantities of organic matter to the soil every year when it dies down, and it must also add nitrogen from its root nodules, but it seems, from observation, to have a somewhat depressive affect on the yield of tung. It may be that this is due to the fact that it is left down as an undisturbed cover, and/or that nitrogen from the root nodules is released mainly when the *Glycine* dies down, that is at a time when the tung is entering its dormant stage. There are no experiments to show whether regular mowing, grazing, discing or ploughing might have a beneficial effect on the tung. *Glycine javanica* in this field has also shown that, even when it is weeded in its early stages, it is not capable of excluding grass and weeds. No weeding has been possible this year and the crop, though luxuriant, is dirty.

Fertilizers and Manures

14. The response shown in previous years to nitrogen has again appeared, though it has not been so clear cut as expected except on a N.P.K. factorial experiment at the Tung Experimental Station. In this experiment nitrogen was the only treatment to show significance, and that was high at the 1 per cent. level. Dressings in this experiment were 3 lbs. each sulphate of ammonia and superphosphate and 1 lb. muriate of potash per tree on trees planted in December, 1943.

A factorial experiment including N.P.K. and cattle manure was started on an estate in November, 1948. The 1950 crop was, therefore, the first to be affected by the treatments. The land is not very fertile, having been badly washed in previous years, and the presence of ant-heaps and sun-scorched trees has made it necessary to spread the experiment over a larger area than is desirable. That uniformity and accuracy are of a low order is indicated both by " Blocks " being significant at 1 per cent. and by a Standard Error equal to 30 per cent. of the General Mean. It is hardly to be expected that treatments laid out in these conditions will produce highly significant *data* in the first year, particularly as the trees were already three years old when the experiment started. The treatments are 3 lbs. each sulphate of ammonia and superphosphate, 1 lb. muriate of potash, and 100 lbs. farmyard manure per tree. The only significant treatment was the interaction between nitrogen and farmyard manure at 5 per cent. This is of some interest when compared with the result of another experiment in which farmyard manure is used, see paragraph 16 below, from which it appears that farmyard manure alone has a depressing effect on yield. Unfortunately, the 1950 results of a similar factorial experiment in the Vipya have not yet been received for analysis.

15. Apart from the fact that nitrogen increases yield nothing is known regarding the size of dressings which will produce an economic return. An experiment was, therefore, started in January, 1949, in which plots of 15 trees in a randomized block trial were given 0, 2, 4, and 6 lbs. of sulphate of ammonia per tree. The trees were then eight years old and the experiment up till then had been one to test the inter-cropping effects of maize, soya, *Calapogonium* and *Mucuna*. The new nitrogen treatments were randomized and super-imposed on the residual effects of the previous experiment. The 1950 crop was the first which could be affected by the nitrogen since flower and bud primordia are formed in the season prior to their growth. The yields are graduated from a mean of 39.8 lbs. seed for no sulphate of ammonia to 45.8 lbs. per tree for 6 lbs. of sulphate of ammonia, but so far the differences are not significant. This is not surprising in view of the age of the trees when the nitrogen was first applied and the effects of the previous experiments which have to be overcome by the present treatments.

Organic Manures

16. The experiment in which tung cake, cotton seed, farmyard manure and artificials are compared, was fully described last year, and it was pointed out that the amounts of nitrogen applied per tree were probably of the order of :—

(i)	Control	.. Nil
(ii)	Artificials ..	.. 0.4 lbs.
(iii)	Farmyard manure	.. 1.5 lbs.
(iv)	Cotton seed ..	.. 2.5 lbs.
(v)	Tung cake ..	.. 3.0 lbs.

A straight analysis this year has shown tung cake, cotton seed and artificials to be better than farmyard manure (P=0.01), tung cake better than control (P=0.01) and control very nearly better than farmyard manure (P=0.05)

An analysis of the combined yields for 1948, 1949 and 1950 shows artificials, tung cake, and cotton seed to be better than farmyard manure and control (P=0.001). There is no other significance though tung cake just fails to be greater than artificials at P=0.05.

TABLE 8

YIELDS PER PLOT LBS. AIR-DRY SEED

Treatments	(i) O	(ii) A	(iii) F.Y.M.	(iv) TC	(v) CS	Sig. Diff. P=0.05	Sig. Diff. P=0.01
1950 ..	66.1	77.1	54.8	84.8	76.7	12.9	17.6
Total 1948–50	269.6	347.7	244.0	376.5	357.7	30.1	55.6

The two points of particular interest in the figures of this experiment are the increasing effect of tung cake, and the apparently depressing effect of farmyard manure. It is too early to draw any conclusions from one season's results but it will be noted that the only significant result in the experiment described in paragraph 7 was the interaction between nitrogen and farmyard manure. This suggests that the farmyard manure was insufficiently rotted when it was applied. This may well be so, but the speed with which any partially decomposed matter disappears during the rains indicates that any shortage of nitrogen induced in this way can only last a very short time.

Diseases

Armillaria Mellea

This disease is very troublesome on an experimental station as not only may it appear for the first time several years after an experiment has been started, but it keeps on claiming new victims year after year. As a result accuracy is lost as it is impossible for supplied trees to catch up with the originals.

There are four fields at the Tung Experimental Station in which *Armillaria* has been particularly bad. In all four, trees had been cut before the estate was purchased, without ring-barking. In one the experiment was abandoned after only five years because there were so many deaths. In another, deaths of experimental trees amount to 10 per cent. and in a third, there are over 25 per cent. vacancies and supplies, largely due to *Armillaria*. In the last case the trees were only planted in January, 1945, and there were already 9.5 per cent. supplies and vacancies when the crop was harvested in 1950 and since then a further 2 per cent. have died.

The experiments at the Station have all been designed so that information can be obtained on the treatments applied and secondarily on the performance of a number of clones within the teatments. It will be realized that such heavy casualties make it impossible to extract any accurate comparison of clone performance, though the broad outline of treatment comparisons can still be obtained.

Botriosphaeria Die-back

18. The collection of information regarding this disease, which has only assumed serious proportions in the last two years, has been one of the main tasks at the Station in 1950. A seperate Report has already been issued on the early work and it will only be briefly reviewed here.

(*a*) Survey of the disease. An intensive survey was carried out on a block of budded trees to determine (i) the incidence of the disease, (ii) the modes of entry of the pathogen, (iii) clonal susceptibility, and (iv) the effect, if any, of manuring with nitrogen.

It was very soon apparent that B-type trees had a far higher incidence of disease than A-types, and that the majority of shoots (at least 60 per cent.) had originally been invaded via the fruit stalks of the previous season's harvest. The next most important entry points (less than 30 per cent.) were the apical buds of main or lateral shoots. It seems a fair inference that the high incidence of the disease on B-types is due to either or both of the following causes :—

(i) B-types, being precocious, have a much larger number of fruit peduncles and sub-laterals (hence apical buds) per unit area of the trees' surface than A-types of the same age.

(ii) The form of the B-types is roughly that of an umbrella with a complete cover of foliage from ground level. The A-types produce whorls of branches at intervals from one main leader which grows vertically upwards. Conditions for spore lodgement and germination are, therefore, much better on B-type trees, where humidity is high and the air comparatively still, than on A-types which are open and well-ventilated.

The only difference in clonal susceptibility that came out of the first survey was that clone 14 had a higher incidence of disease than clone 10, although the latter has always been slightly the higher yielder of the two. This is probably not important at this stage when there are several years backlog of dead and diseased wood to be removed from the trees.

TABLE 9

BOTRIOSPHAERIA INVESTIGATION

1ST ROUND DECEMBER, 1949/JANUARY, 1950

Clone	10	14	N24	M8	F9	Sig. Diff. P=0.01
Mean No. shoots killed per tree	22.5	33.4	2.6	0.9	0.9	8.2
Mean length of wood killed per tree in inches	229.0	348.7	20.0	7.4	8.1	99.4

NOTE.—Clones 10 and 14 are B-types and the others are A-types.

The second 1949–1950 round showed a very slight increase in the number of shoots killed, and a greater increase in the total length. This confirmed the impression gained during the survey that there were more big branches killed. In these cases the pathogen must have been present for more than one year.

Table 10

Comparison of Results on Rounds 1 and 2
1949–1950

Observations made	Round 1	Round 2
Total No. of shoots killed	4,344	4,497
Total length of shoots killed	44,229 ins.	49,749 ins.
Mean length per shoot	10.2 ins.	11.1 ins.

In this second round, clone M8, which had shown the lowest incidence before, showed a very greatly increased incidence, so much so that it was almost twice as severely attacked as any other clone. It is difficult to explain this sudden rise, though it may be noted that this was the experimental area referred to in paragraph 15 in which M8 showed such a spectacular increase in yield.

It had been hoped to get both rounds of investigation for the season 1950–51 on this experiment finished before the end of 1950, but the lack of labour made this impossible. The first round, however, showed much the same result as the first round in the previous year (*see below*) except that incidence in clone 10 was greater than clone 14 (at P=0.02), whereas it was vice versa in 1949. The incidence on M8 in the first round of 1950–51 is greater than on the other two A-type clones, but not significantly so. Such an increase is not surprising in view of the heavy crop in 1950 and hence the larger number of fruit stalks providing points of entry for the fungus.

Table 11

Comparison of Round 1, 1949, and Round 1, 1950

Clone		10	14	N24	M8	F9	Sig. Diff. P=0.05	Sig. Diff. P=0.01
Mean No. shoots ..	1949	22.5	33.4	2.6	0.9	0.9	6.3	8.2
Killed per tree ..	1950	94.1	62.7	12.4	23.4	8.4	24.7	32.7

The control of die-back is discussed below, but it may be mentioned here that the hope that a policy of pruning out all diseased wood might sharply reduce the incidence of the disease has not been borne out so far. The figures, both for number of shoots and shoot length killed, in Round 1, 1950–51, are considerably greater than Rounds 1 and 2 of 1949–50 added together.

Table 12

Comparison of Sum of Rounds 1 and 2, 1949–50 and Round 1, 1950–51

	Rounds 1 and 2 1949–50	*Round 1 1950–51*
Total No. of shoots	.. 8,841 ..	14,485
Total length of shoots	.. 93,978 ins. ..	246,771 ins

Control of Botriosphaeria Die-back

19. An experiment designed to supplement the information obtained from the one described above, and also to allow for spray treatments, was started in January, 1950. Unfortunately, lack of suitable spraying equipment, and insufficient knowledge of the life cycle of the fungus, has made it impossible to do anything in 1950, beyond recording incidence of disease.

The necessary dusting and spraying machinery is now available, and the Plant Pathologist's investigations have enabled him to advise on the correct time for spraying.

Since the fungus cannot be touched once it has entered a tree, and since also, once it is inside it continues to penetrate further, the removal of dead and diseased wood is an essential part of any programme of control. It has been advised by this Station that all diseased wood should be removed by cutting well back into healthy tissue with sterilized secateurs, that all such wood should be collected and burned, and that all cut stems should be protected immediately by the application of fungicidal wax. It has also been pointed out in writing and demonstration that it is good pruning practice to cut back to a bud or lateral shoot and not to leave a " snag ".

The Tung Chemist produced a wax made from beeswax, paraffin wax, gear oil and Bordeaux mixture, which has given very satisfactory results on the whole. The observed incidence of disease through a waxed stump has been only 1.3 per cent. out of 2,570 cuts made in 1949–50. It had the disadvantage, however, of being expensive and for this reason few planters used it. Other formulas, prepared by the Chemist, using cotton seed tar as the base, have been tried during the last few months of 1950.

One problem which has not yet been overcome is that of making the cap of wax adhere to the stump when it exceeds about $\frac{3}{4}''$ in diameter. The flow of sap in these cases is so great during the growing season that the wax is "floated" off. This is of particular importance in the cutting back of stocks to force out the bud. Infection with *Botriosphaeria* has been shown to kill a number of buds. An experiment was, therefore, started to find out if this could be obviated by cutting back the stock in the dormant season when the flow of sap is very slight. The difficulty is that the loss of shade provided by the crown of the stock comes at a time when hot sun will scorch the stock, and so provide an entry point for various fungi. The Plant Pathologist has shown that this can be overcome by shading, and the bud grows out satisfactorily. In order to retain the shade of the leaves stocks were also "ringed" and "notched" just above the bud. Ringing gave good results, but the notching had almost no effect in forcing the buds into growth. When the buds, forced out by ringing, had grown enough to provide shade from their own leaves the stocks were cut back at the ring and the amount of bleeding was negligible. This method, therefore, is feasible, but presupposes stocks budded the previous year, but not cut back. As this means a delay of one year it is only likely to be useful in the case of budding done too late for forcing into growth the same season.

20. In one experiment conducted by the Plant Pathologist to test various fungicides, stems were cut back at random and the different waxes applied. The results of the experiment were disappointing and none of the preparations was successful in preventing invasion by the fungus. However, it was noticed that in the cases where the stem remained healthy and callused well a bud had invariably grown out very close to the cut end. This supported the teaching of cutting to a bud and an experiment was laid down to test the relative effects of careful and random pruning, and at the same time of cotton seed tar, fungicidal wax and no protection. Between 30 and 35 stems were cut in each case and the results obtained four months later are summarized in Table 13.

TABLE 13

PRUNING AND WOUND DRESSING

Treatment			*Dead snags per cent.*	*Healthy shoots per cent.*
(*a*)	Cut to a bud	No wound dressing	16	84
	Cut at random		74	26
(*b*)	Cut to a bud	Cotton seed tar only	15	85
	Cut at random		86	14
(*c*)	Cut to a bud	Fungicidal wax	8	92
	Cut at random		46	54

The experiment was on a small scale and not laid out for statistical analysis, but it provides evidence to show that careful pruning is of first importance, greater even than subsequent protection with fungicidal wax. It indicates that cotton seed tar without any fungicide added is unlikely to be of much use, whereas a fungicidal dressing such as the one formulated by the Tung Chemist, the use of which was advised to all growers, can be useful in preventing the entry of the pathogen through a small wound. It seems that cotton seed tar may not be altogether useless as it was observed that callus growth in the cases where tar or wax were applied was distinctly better than where no dressing was used. This may be due to the protection afforded to the cambium against loss of moisture so that callus growth is able to begin at once.

Tung Chemical Work

21. The Laboratory was only fully completed at the very end of the year and up to that time only a limited amount of work was possible. In addition to supervising the equipment of the Laboratory it was necessary to train the African Staff who commenced work this year. Next year will be the first full working year of this Laboratory.

Oil Yield of Trees

22. The programme of work includes a detailed study of the variation in yield and chemical characteristics of the oil from various clones, together with investigations into the effect of fertilizers on these values. As the amount of work involved is considerable there was little point in starting it early in the year when it could only have been tackled piecemeal and since the spectrophotometer had not arrived. Preliminary work regarding methods has been done, prior to commencing the survey when this season's crop matures. The oil content of the kernels is known to vary in the range approximately 56–66 per cent. oil content, and there is also the variation within a clone and within a tree to be considered.

Extraction of the Oil

23. The factory investigations were carried out in co-operation with the Nyasa Tea Estates Ltd. As the percentage of oil expelled, based on the amount of seed received at the factory, was only 27 per cent. in the 1949–50 expelling season (*i.e.*, on the 1948–49 crop) the importance of this work can be seen. Yields of 30–33 per cent. should be obtained although allowance has to be made for a fair proportion of dirt and other extraneous material which remains when the seed is collected and bagged. With most oil seeds, the efficiency of expelling is not always of critical importance as economically any loss of oil in the residual cake is covered by the enhanced value of the cake as cattle feed. However, as tung cake has irritant properties when eaten, its use only as a fertilizer makes maximum extraction of the oil essential.

24. Two Maxoil machines, made by Rose, Downs and Thompson have been in use until this year, when a newly designed machine introduced by R. Sizer & Co. was installed. This new machine is reputed to deal with whole kernels, with the addition of little or no shell (the Maxoil works with approximately 30 per cent. in the feed), and, therefore, has potential advantages as regards throughput and possible use

of the cake. It was, therefore, necessary to obtain data on the comparative efficiencies of the two machines. This work was undertaken in the period September–December, and in the course of this over 100 samples of seed, cake, oil, etc. were examined after carrying out 15 experimental runs at the factory. With the Maxoil machines an oil yield of 28–29 per cent. was obtained, the cakes having an oil content within the range of 7–13 per cent., although the figure of 9–12 per cent. was more general. Higher oil contents (up to 20 per cent.) were found in cake taken from ordinary production.

25. The Sizer machine did not prove satisfactory when dealing with whole kernels, owing to insufficient cooking, but with disintegrated meal, a cake containing 5–6 per cent. oil was produced. Occasionally, a figure lower than this was obtained. Unfortunately, there were practical difficulties at the factory when using the Sizer machine on disintegrated meal and it was decided to discontinue using it until further information was obtained from the makers regarding improved cooking equipment to enable it to be used for whole kernels. That unsatisfactory cooking was the cause of the trouble with whole kernels was proved by increasing the heat at the top kettle when examination at the exit of this kettle showed the kernels to be appreciably more softened. Unfortunately, the only means of increasing the heat at the top kettle was by means of open steam. This increased the moisture content in the meal, gave less efficient extraction, and, therefore made quantitive examinations impossible. Also, by allowing the meal to stand in the kettle for a longer time than was obtained on continuous running, and then operating the expeller it was found that the oil content of the residual cake gradually increased as the less efficiently cooked material passed through the expeller. It was, therefore, concluded that potentially the Sizer machine appeared of high efficiency but that no further assessment could be made until the manufacturers either recommended or agreed to modified heating kettles.

26. It was also clear that the Maxoil machine was not running under optimum conditions since the temperature of the expelled oil (70–80 C.) was not as high as it should have been, and that the cake was of higher oil content than the 5–6 per cent. expected of a mechanical expeller of this type. In November an engineer from the manufacturers visited the factory, during an inspection of their equipment in Africa. He agreed that their plant was not operating efficiently due to unsatisfactory cooking, and he suggested mechanical modifications to give a higher feed and improved cooking. Experimental runs under the new conditions have shown some improvement, although not bringing the expeller to its expected efficiency. Confirmatory experiments are to be made.

During the year the factory engineers have installed equipment which gives improved settling of the foots from the oil, this being based on laboratory recommendations. Oil left in contact with foots deteriorates due to hydrolysis causing increased acidity. The oil obtained from the expellers last season contained 15–20 per cent. foots, which in turn contained approximately 60 per cent. oil. By a series of baffles the amount of sludge was reduced to 10–15 per cent., this mixture then being allowed to settle in large tanks. Laboratory experiments indicated that the rate of settling was increased six-fold if the oil was settled at the temperature at which it left the expeller instead of being allowed to cool. A smaller heated tank for preliminary settling has now been installed, the clear oil then passing to the storage tanks. This arrangement has permitted a greater production rate, since there have been no delays while the sludge settled from the oil, and there has also been less risk of deterioration. The factory has also been improved by the introduction of a new decorticator and sifter, which produces a cleaner material for feeding to the expeller. Regarding any changes in the oil on storage in drums prior to use, results so far show a slight change in the oil over a period of several months, but sufficient samples have not yet been received from the selling agents to assess this fully.

The Quality of the Oil

27. Nyasaland *A. montana* oil is slightly darker than the *A. fordii* and is also darker than Argentine or Brazilian *A. fordii* oil. It is, however, of much superior colour to the Chinese oils, which are expressed under uncontrolled conditions. Tests have been made to improve the colour of the oil and an oil of water-white clarity has been obtained. As, most probably, only a portion of the oil exported would be required in this condition for manufacturers of high quality varnishes and white paints, it is not considered to be economic to treat the oil in Nyasaland, but leave such processing to the oil users themselves.

28. Regarding the chemical quality of the oil, *A. montana* oil because of its lower content of elaeostaeric glycide (approximately 75 per cent. against 80 per cent. in *A. fordii* oil) has different chemical characteristics. These are reflected in the physical properties of the oils, chiefly the time taken for polymerization in the standard heat test. The specified maximum times for this are 15 minutes for the *fordii* oil and 22 minutes for *montana* oil. While Nyasaland *A. fordii* oil has complied with this figure, the *A. montana* oil has generally showed a gelation time somewhat in excess of 22 minutes. During the present expelling season the oil, (*i.e.* from 1949–50 crop) has shown a gradual increase in this figure until it became 25 minutes. The refractive index and iodine values fell correspondingly.

29. There were several causes of these variations to be examined. The more obvious changes coincided with the introduction of the new type of expeller, but this possibility was eliminated when it was found that oil from this and the original machine showed similar characteristics. As the expellers are known to be working at less than maximum efficiency, there is the possibility of " fractional expelling ", but as they are used under identical conditions to those of previous seasons, this explanation is rather remote.

30. It is possible that the causes are climatic *i.e.* the delayed effect of the 1948–49 drought, since it is well known that the oil content of seeds of the same plant varies according to the climatic conditions under which the plant is grown. It is, however, significant that concurrent with these changes there have appeared certain new visual leaf symptoms that suggest nutrient deficiencies. These first appeared at the end of the last growing season, and are dealt with below in paragraphs 32–35.

31. In addition to the above investigations on the expelling of the oil, samples of each export consignment, (about 10–15 tons each), are examined in the laboratory. Twenty-five consignments were despatched in the 1949–50 expelling season, and so far 28 have been despatched from the 1949–50 crop. Apart from the points already mentioned, the oil complied with the specification.

Nutritional Problems

32. Work on this aspect has been delayed, although over 100 soil samples have been partially examined. At the end of the last season (January–March, 1950) several leaf symptoms were apparent. Of the three main types, the first involves a gradual chlorosis, the second a marginal scorch, and the third interveinal spotting followed by necrosis. These made their appearance earlier this season. In addition a new sympton, involving production of a variegated chlorotic leaf pattern, made its apearance in the nursery.

33. In February and March profile pits were examined on two estates showing these deficiency symptoms. No sharp difference could be found in the concentration of major nutrients, and in the physical characteristics of the soils, as between those areas showing the deficiency symptoms, and those in which the symptoms were not apparent. As the laboratory here was not yet complete, the co-operation of the Chief Chemist, Department of Agriculture, Salisbury, was obtained in analysing the leaves from different areas. No conclusion could be drawn from the content of calcium, iron, potassium, manganese, molybdenum, and magnesium in the deficient and apparently satisfactory leaves. The manganese content of leaves was lower than that of the normal ones, but both were above the minimum quoted as found necessary for *A. fordii* in America. It does not, however, follow that a similar level would meet the requirements of *A. montana.*

34. Small scale spraying and injection experiments in November and December have indicated that the symptoms may be alleviated by copper and manganese. Confirmatory tests are in hand, although in the nursery, these are not possible since the onset of the rains have led to the disappearance of the symptoms. This in itself is also indicative of a manganese deficiency. In the areas where response to the copper applications have been obtained, cupping of the terminal leaves is apparent, and this is a further symptom of copper deficiency. Zinc deficiency has already been indicated in several tung areas in Nyasaland and it may be noted that in America reports of copper and manganese deficiencies along with that of zinc have been made on several occasions.

35. The effects of copper deficiency are far reaching. Examination of *A. fordii* in America has shown that insufficient copper decreases the oil synthesis within the seed. It has been found that when the copper-nitrogen ratio is decreased, an increase in nitrogen metabolism occurs at the sacrifice of carbohydrate and hence oil synthesis. Small changes in copper content affect the photosynthesis within the plant quite out of proportion to the copper content variations involved, and also these changes may occur before the copper content is sufficiently low to cause visual symptoms.

36. Soils from fields at the Tung Station have been examined with regard to phosphate availability. Plots on field 1 were found to contain in their top soils from 12 to 16 p.p.m. of phosphorus in the unmanured plots and from 30 to 35 p.p.m. in those where phosphate had been applied. A sharp distinction, however, could not be made as there were higher figures (27 p.p.m.) on the unmanured plots and lower ones (20 p.p.m. where phosphate had been applied). These samples were taken in February, and where superphosphate had been applied the previous December, the concentration of phosphorus was approximately 50 p.p.m. The soil in field 1 may, therefore, contain sufficient phosphate for the first years of growth since no response has been shown in the yields obtained.

37. The acidity and lime requirements of the soils on the experimental fields of the Station have been determined. The soils are of medium acidity, their pH being generally in the range of 5.6–6.2, with the coresponding lime requirement of 20–30 cwts. per acre. As tung requires an acid soil, this full amount cannot be applied, and it is necessary to investigate the effect, on the general health of the tree, of any lime applied to increase the phosphate availability.

38. Other work related to these trials has been the analysis of the local limestone, (found to contain 12–18 per cent. MgO.), and an examination of the effect on soil kept in cement asbestos plots. These were the only ones available for pot tests and it was suspected that their alkalinity might adversely affect the seedlings. This was confirmed by experiment, the pH of the soil rising from 6.2 to 7.5 and it was necessary to give the pots two coats of bituminous solution before use.

39. In February, a preliminary examination was made of the soils from field 7, where various cover crops are under trial for their effect on soil fertility and growth of tung. The nitrogen contents were 0.14 per cent., 0.13 per cent., 0.11 per cent. and 0.12 per cent., in soils taken respectively from plots growing maize (maize and soya in alternate years), soya beans, *Glycine javanica*, and grass cover only. A fuller examination is at present being made to follow seasonal changes in the soil composition.

Miscellaneous Problems

(2) *Fungicidal Preparations*

40. Among the miscellaneous problems dealt with, the chief one has been the development of fungicidal dressings for use after the pruning treatment recommended to eradicate *Botriosphaeria* die-back. Such a dressing must be water resistant and fungicidal, and also be sufficiently plastic to allow callus formation under the coating, and yet be hard enough to avoid " running " under the heat of the sun. In addition it must be capable of easy preparation by planters from readily available materials.

41. Paints had previously been used on the Station after grafting—but these coatings had been found too thin to " give " as the callus formed, leading to the formation of cracks through which infection readily entered. This objection also applied to pastes made from Bordeaux mixture and linseed oil.

42. Normal grafting waxes are usually based on mixtures of rosin and waxes, with smaller additions of talc or similar filler to prevent undue running of the wax. Rosin and beeswax ratios varying from 10 : 1 to 2 : 1 have been recommended but, in conjunction with Bordeaux mixture used as the fungicidal constituent and also as a filler in place of talc, these formulations proved excessively hard due to the formation of copper and calcium resinates.

43. A mixture suitable for cold application would be more convenient in use, but its efficiency on small branches must be such that the edges of the cut portion are sufficiently covered—a condition more readily met by hot application. Tests were first concentrated on mixtures of beeswax, gear oil, and Bordeaux mixture. A formulation for satisfactory application had a percentage composition of 44, 44, 12 respectively of these materials, giving a copper content of 2.4 per cent. Exposure tests were also made on the experimental compositions and it was found that after a few weeks this material cracked prematurely, due to incomplete compatability of the beeswax and hydrocarbon oil. Paraffin wax had been reported as unsatisfactory for grafting waxes owing to its hardening characteristics and also to its low viscosity when warmed. But its incorporation in conjunction with beeswax led to decreased cracking, and gave a satisfactory consistency for brush application, when warmed or cold application was possible with a suitable knife. This formulation was as given above except that half the beeswax portion was replaced by paraffin wax.

44. For the testing of proprietory fungicides such as Aretan, the wax medium consisted of beeswax, paraffin wax and gear oil in the proportion 30, 20, 50. As a more uniform dispersion of copper can be obtained by its inclusion in the form of copper soaps, a mixture containing beeswax, paraffin wax, gear oil and copper soaps in the proportion 28, 18, 44 and 12 was made (resultant copper content 1 per cent.). This was given a trial to ascertain its possible phytocidal action when the copper was in this oil soluble form.

45. Unfortunately, the existence of the locally available cotton tar was not known when the first work on some 40 various formulations was undertaken. Although the recommended wax proved satisfactory, its high cost may have deterred some planters from taking the necessary action against the disease. Alternative dressings based on cotton tar have, therefore, been developed. At the same time, these materials are suitable for cold, and therefore, more ready, application. Consideration was also given to the possibility that any residual phenolic compounds (*e.g.* gossipol) in the cotton seed tar might provide sufficient fungicidal action to make the addition of other materials unnecessary.

46. Cotton seed tar itself proved too thin for satisfactory application. Paraffin wax, though cheaper and more readily available than beeswax was found unsuitable for bodying the tar, since even in amounts up to 50 per cent., thinning and running occurred. Beeswax was therefore, essential although the addition of only 5 per cent. to the cotton tar was necessary to give it the required consistency.

47. As previous trials of materials containing copper compounds other than Bordeaux mixture, had given inconclusive results, cotton seed tar containing 1.2 per cent. cuprous oxide was included for trial. It was also found that cotton seed tar and Bordeaux mixture in the proportions of 90 : 10, gave a paste of satisfactory consistency, and was included in the trial in case cotton seed tar proved to have insufficient fungicidal action when used alone.

48. As excessive sap exudation had caused difficulties with the waxes, an emulsion of cotton seed tar has been prepared to see if this would overcome the problem and thus facilitate application on large wounds. This formulation consists of cotton seed tar emulsified in an equal amount of 2 per cent. ammonia solution, and is now to be tested.

MAKANGA EXPERIMENTAL STATION, CHIROMO

Agricultural Officer in charge .. W. V. Rose
Field Officer .. .. G. A. Butler

No Cotton Year Experiment

49. Pearson and Mitchell* recommended that for the Lower River area, cotton should be grown in such a way that it would pass into senescence and be ready for uprooting before the 31st July, thus the number of long-term pupae of red bollworm *Diparosis castanea* capable of " carrying over " until the succeeding crop would be reduced.

At present all cotton on the Lower River must be uprooted before 31st October. In the presence of heavy bollworm attack a large proportion of the cotton crop, and in some areas the entire crop, is not set before the 31st July, and would, therefore, be lost if the uprooting date were changed to 31st July with the present date of planting and growing conditions. Pearson and Mitchell, therefore, recommended that no cotton should be grown for one year, in order to reduce the bollworm population to a low level and thus, by removing the delaying effect of bollworm attack, make it possible to uproot cotton before 31st July without losing any of the cotton crop.

Almost the entire Lower River cotton crop is inter-planted with maize and it was not known exactly how cotton would behave when interplanted with maize in the absence of bollworm.

It was decided, therefore, to carry out the control measures recommended by Pearson and Mitchell on a small scale before applying them to the Lower River as a whole. The Experimental Station at Makanga, near Chiromo, was chosen as the experimental site and a quarantine area with a radius of five miles was established around the Station. No cotton was grown on Makanga or in the quarantine area in the 1948–49 season and the quarantine was maintained during the 1949–50 season and three cotton experiments, occupying 10 acres were established at Makanga. These experiments were designed to determine :—

(1) Optimum spacing of maize which would permit the cotton to be harvested by 31st July without unduly reducing maize yields.

(2) Optimum date of planting of cotton and the last date on which cotton planting could be permitted.

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* *A Report on the Status and Control of Insect Pests of Cotton in the Lower River Districts of Nyasaland.*—Government Printer, Nyasaland.

(3) The optimum date for removing maize shade, thereby permitting more rapid development of cotton without reducing maize yields.

Unfortunately, the radius of five miles within which no cotton was grown proved to be an inadequate barrier to *Diparopsis* moths emerging outside the area. The cotton at Makanga being the only cotton within the area received concentrated attention and cotton planted there suffered in consequence. Records of egg-laying by moths, and counts of larvae were made both on the Station and outside the quarantine area and these proved that bollworm attack was more severe on the Station than outside.

The experiments carried out, although the cotton was severely attacked by red bollworm, gave some interesting results which are recorded below.

50. *Layout :*

Randomized Blocks, 9 replication Plots, 20×8 yds.

Treatments :

Cotton interplanted in furrows between maize which had been planted on ridges at 3ft.×3ft. on the 4th December, 1949. Cotton planting dates were as follows :—

(1) 14th December.
(2) 21st December.
(3) 28th December.
(4) 8th January.
(5) 30th January.

Results :

The maize yield was uniformly good on all the treated plots and averaged 3,010 lbs. of grain per acre. Cotton gave yields as set out in Table 14, which gives the totals up to 31st of July, 1950, on which date all cotton was uprooted.

TABLE 14

YIELDS OF SEED COTTON INTERPLANTED BETWEEN MAIZE ON VARIOUS DATES

Planting dates	*Dec. 14th*	*Dec. 21st*	*Dec. 28th*	*Jan. 8th*	*Jan. 30th*	*Sig. Diff. P=0.05*
Yield of Seed Cotton in lbs. per acre at 31st July	226	218	178	110	35	77
Final Yield of Seed Cotton in lbs. per acre at 31st October	404	430	434	312	223	133
Percentage of Total Crop harvested before 31st July	55.9	50.7	40.9	35.3	15.7	

Although there is no significant difference between the final yields of cotton planted between 14th December and 8th January the cotton planted during December was significantly better at 31st July than cotton planted in January.

Thus in spite of the fact that the plots of early planted cotton contained the only cotton within several square miles and were consequently heavily attacked by red bollworm, they produced their crop appreciably earlier than the later planted plots.

While the planting of cotton between established maize appears to have a depressing effect on the total cotton yields if planting is too soon after the maize planting date, this deleterious effect does not seem to operate until the dry season is well advanced, and would therefore not appear to be a deterrent to advocating the early planting of cotton if the intention is that the cotton should be uprooted by 31st July.

Thus the earlier the cotton is planted the more rapidly is the cotton crop produced in spite of the concentration of red bollworm attack on the isolated plots planted in this experiment. It is reasonable to assume that if all cotton were planted at the same time, the incidence of bollworm damage on any one plot would be reduced and consequently the accelerating effect of early planting would be even more marked than in this experiment.

Date of Harvesting Experiment.

51. It had been found by other workers both on maize and barley that these crops could be harvested some time before they were normally judged to be ready for harvest, *i.e.* completely dry, without causing any reduction in yields. Pearson and Mitchell carried out an experiment on the Lower River in 1944 to determine what effect early harvesting of maize would have on the earliness and yield of the interplanted cotton. The trial showed that while there was no difference in yield of maize from the various treatments, the effect of different methods of early harvesting of maize produced a significant increase in the yield of the interplanted cotton (except where the maize had been layered).

A modified form of this experiment was carried out in 1945 and again repeated in 1950. The same treatments were applied, except that all cotton was left until 31st October in 1950, whereas in 1945, cotton from some treatments was uprooted on 31st July.

The treatments applied in 1945 were :—

(i) *African Method Control :* Maize left standing in the field until fully mature, *i.e.* 133 days after planting.
Cotton cut out at the end of October.

(ii) *Stooked Early :* Maize stalks cut at ground level, carried off and stooked at 105 days (15 weeks) after planting.
All cotton cut out on 31st July.

(iii) *Stooked Late :* Maize cut at ground level, carried off and stooked at 119 days (17 weeks) after planting.
All cotton cut out on 31st July.

(iv) *Layered :* Maize bent over at about 18 ins. above ground level at 119 days and left until dry when the cobs were harvested.
All cotton cut out on 31st July.

(v) *Stripped :* At 105 days after planting the tops of the maize plants, above the cob, were bent over and all leaves removed from the plants. The cobs were harvested at 133 days.
All cotton cut out on 31st July.

Spacing of maize and cotton was the same as in the 1944 experiment. In order to determine whether the maize from different treatments would give different shelling out percentages because of different moisture contents, two samples were taken at random from the maize harvested from each plot and each of these was subsequently bulked with one sample from each of the other plots of the same treatment, resulting in two samples of 120 cobs from each treatment.

These samples were weighed separately, shelled and the grain weighed to give the shelling out percentages from each treatment.

The same treatments were applied to the maize when the experiment was repeated in 1950. Maize was planted on 10th December and cotton 10th January. Records were kept of the cotton harvested at each picking and the cotton from all treatments was uprooted at the end of October instead of uprooting the cotton on the treated plots on 31st July as in 1945. Samples of maize were taken as on the previous occasion but after shelling and weighing the grain was dried for a further period and weighed again giving a second series of shelling out percentages given in Table 15 as (*a*) and (*b*) respectively.

TABLE 15

	MAIZE						COTTON			
							Lbs. seed cotton per acre			
	Yield in lbs. grain per acre		*Shelling out percentage*				1945 *to 31st July*	*To 31st Oct.*	*To 31st July*	*to 31st Oct.*
	1945	1950	1945	1950						
				(*a*)	(*b*)	(*a-b*)				
Treatment 1 ..	1,933	2,668	66.3	68.6	64.3	4.3	—	539.6	297	461
2 ..	2,090	2,354	69.2	67.3	64.5	2.8	685.4	—	498	662
3 ..	2,262	2,771	67.0	68.8	62.3	6.5	665.2	—	389	560
4 ..	2,162	2,446	67.9	72.2	64.6	7.6	490.6	—	356	490
5 ..	1,888	2,357	67.0	69.8	68.8	1.0	415.0	—	414	563
Sig. Diff. (P=0.05)	Not sig.	305					Not significant		110	118

The differences between maize yields were not significant in 1945 (*cf.* 1944) but in 1950 the early treatments *i.e.* stooking at 105 days and stripping at 105 days, had a depressing effect on maize yields as compared with normal African practice and late stooking.

Late stooking at 119 days gave better yields than layering at 119 days. The difference between the shelling out percentages at first shelling and after further drying indicates that the maize grain dries out more thoroughly when *stooked early* or *stripped* than it does under any of the other treatments. In that case the resistance to weevils in storage by the drier maize would be an advantage from the point of view of the African who stores his maize on the cob in unsealed cribs.

In 1945 the yields from the untreated cotton which was harvested up to the end of October was no greater than the yields from the treated plots at 31st July. Thus there was no loss in yield from uprooting treated cotton at 31st July as compared with normal. In 1950 comparison of the yields of seed cotton obtained up to 31st July shows that the " early " treatments, *i.e.* stooking and stripping at 105 days, gave better yields than the control. The difference between the yields from late stooking and the control just failed to be significant. Only stooking at 105 days is better than the control when the total yields up to 31st October are considered.

52. A trial conducted at Makanga in 1944 (loc. cit. para. 151 page 41) showed that yields of cotton interplanted between maize were considerably improved by increasing the inter-row spacing of the maize, and that the cotton also produced a much earlier crop at the wider maize spacings.

This trial was repeated in 1950 at Makanga Experimental Station, and in spite of the failure of the quarantine area to prevent the influx of red bollworm, the results are nevertheless of interest in comparison with the previous results. The trial was of the split-plot design (with six replications) consisting of two main plots containing the early and late plantings of maize, with each main plot sub-divided with eight sub-plots carrying the following treatments :)

(i) Maize 3 ft. × 2 ft. thinned to leave 2 plants per hole.
One row of cotton interplanted between the maize.

(ii) Maize rows 3 ft. × 2 ft., 4 plants per hole.
One row of cotton interplanted between the maize.

(iii) Maize 4 ft. × 18 ins., 2 plants per hole.
One row of cotton interplanted between the maize.

(iv) Maize rows 4 ft. × 3 ft., 4 plants per hole.
One row of cotton interplanted between the maize.

(v) Maize rows 6 ft. × 6 ins., 1 plant per hole.
Two rows of cotton interplanted between the maize.

(vi) Maize rows 6 ft. × 12 ins., 2 plants per hole.
Two rows of cotton interplanted between the maize.

(vii) Maize rows 6 ft. × 4 ft., 4 plants per hole.
Two rows of cotton interplanted between the maize.

(viii) Pure stand cotton.

Cotton was planted 2 ft. apart in the row throughout. The density of the maize is the same for all treatments except in Treatment vii, in which the density is halved. Early maize was planted on 5th December and the late maize on 20th December. Cotton was planted on the 9th January.

TABLE 16

COMPARISON BETWEEN EARLY AND LATE PLANTED MAIZE

Treatment	*Yields in lbs./acre*	*Sig. Diff.* (P=0.05)
Early planted maize ..	2,245 ..	406
Late planted maize ..	1,577 ..	

TABLE 17

YIELD OF SEED COTTON PLANTED BETWEEN MAIZE AT DIFFERENT SPACINGS

	Maize Lbs. Grain/ Acre	*Seed Cotton Lbs./Acre Cotton picked to 31st July*			*Cotton picked to 31st October*			
		Between Early Maize	*Between Late Maize*	*Mean*	*Between Early Maize*	*Between Late Maize*	*Mean*	*Percentage harvested before 31st July*
Treatment (i) ..	2,244	217	127	172	262	183	232	77.5
,, (ii) ..	2,244	169	141	155	224	202	203	72.8
,, (iii) ..	2,117	153	157	155	212	201	206	75.2
,, (iv) ..	2,015	185	139	162	236	183	209	77.5
,, (v) ..	1,653	214	186	200	267	213	240	83.3
,, (vi) ..	1,753	186	250	218	268	339	303	71.9
,, (vii) ..	1,353	388	302	345	492	381	436	79.1
,, (viii) ..	—	492	459	475	549	529	539	88.1
Sig. Diff. (P=0.05) ..	304	60	60	43			123	

These yields of maize from the 3 ft. and 4 ft. spacings are equal and better than yields from 6 ft. spacings. Comparison of yields of cotton up to 31st July shows :—

Treatments 6, 7, 8 are significantly better than 1, 2, 3, 4,

Treatment 5 is significantly better than 2 and 3.

Treatment 8 is significantly better than all other treatments.

Treatment 7 is significantly better than all other treatments except No. 8.

The interaction better date of planting and spacing is also significant.

The additional cotton picked between July 31st and October 31st resulted in treatments 7 and 8 being equal and better than all other treatments.

Conclusions from the planting, harvesting and spacing experiments reported above may be summarized as follows :—

(i) It has been shown that pure stand cotton planted on 9th January was 25 days ahead, at 31st July, of cotton planted on the same day but interplanted between maize spaced at 3 ft. though the maize was planted early.

(ii) Cotton planted on 14th December between maize spaced at 3 ft. was 19 days ahead of cotton planted on 8th January.

(iii) Similarly cotton planted on 10th January between maize spaced at 3 ft. × 4 ft. but stooked at 105 days from planting was 19 days ahead of cotton between maize harvested in the normal fashion.

If these two latter factors are additive it would appear that cotton planted between normally spaced maize in mid-December would, if the maize were harvested early, imitate in earliness, not necessarily in yield, pure stand cotton planted in January. That is, one would expect some 90 per cent. of the total crop to be harvested before the end of July even in the presence of bollworm attack.

Since cotton planted as a pure stand in *January* would, in the absence of bollworm, set its crop and be ready for uprooting by the 31st July, it follows that cotton interplanted between normally spaced maize in *December* would also, in the absence of bollworm, be ready for uprooting by 31st July. Thus if by some means, such as a non-cotton year, bollworm could be eliminated, a new regime involving only December planting of cotton and early harvesting of maize and July 31st uprooting could be established which should maintain control of the bollworm population.

This conclusion is of interest because it would involve no interference with the spacing of maize interplanted with cotton.

However, such a conclusion, although encouraging, has been based on only one year's experiments, and on the assumption that factors (ii) and (iii) above are additive. Further trials in which date of planting and early harvesting are combined in one treatment will have to be conducted to test such assumptions.

Maize—Sesame Interaction Experiment.

53. This experiment was started in 1947 with the object of determining a satisfactory method of interplanting sesame with maize ; a satisfactory result would not only increase sesame production on the Lower River, but would also provide an alternative cash crop if cotton is abandoned for one year as a measure to control red bollworm. The sesame was planted directly into the plots. The difference between yields of maize were not significant but sesame planted between maize spaced 3 ft. × 3 ft. and unthinned (control) gave a yield of 136 lbs. per acre of sesame which compared favourably with the yield from pure stand sesame of 194 lbs. per acre. Planting in February gave the most promising results. In 1948 sesame was broadcast (*cf.* previous year) in a small nursery in the hope that the plants having become well established would stand up better to the maize competition when subsequently interplanted. Conditions were, however, unfavourable and the best yield obtained was 54 lbs. per acre. The best yields, although the differences were not significant, were obtained from sesame planted on 12th February.

The experiment was repeated in 1949 but owing to the drought no crops were harvested.

Layout of Experiment.

The experiment is designed on the factorial principle and consists of five blocks each with 12 plots containing all combinations of four spacings of maize with three dates of planting of sesame. Each plot is 126 sq. yds. in size. The entire field was made up into ridges 3 ft. apart. Maize was planted on top of the ridges and sesame in the furrow.

The following treatments were applied :—

(i) Maize planted in rows 3 ft. apart, 1½ ft. apart in the rows and thinned to two plants per hole.

(ii) Maize spaced 3 ft. × 2 ft. with three plants per hole.

(iii) Maize spaced 3 ft. × 3 ft. with four plants per hole.

(iv) Maize spaced 3 ft. × 3 ft. and left unthined, *i.e.*, African style.

The sesame was transplanted from nurseries at a spacing of 3 ft. × 2 ft. between the rows of maize. Transplanting was carried out on the following dates :—

(*a*) 16th February
(*b*) 2nd March
(*c*) 18th March.

Both the maize and sesame used were the varieties normally grown by African cultivators in the District. Five seeds of maize were planted in each hole and the plants were subsequently thinned as required by treatments.

Yields of maize (in lbs. of grain per acre) were as follows :—

TABLE 18

Treatment No.	(i)	(ii)	(iii)	(iv)	Sig. Diff. P=0.05
Yields in lbs. per acre	2,638	2,968	2,564	2,732	Not significant

The sesame was a complete failure because of heavy attack of Flea-beetle and also dry conditions.

Organic Manurial and Mulching Experiment.

54. The African cultivator on the Lower River normally leaves the stubble and debris from his previous crop lying in his garden after harvest time to be collected and burned in October together with any weeds which may have grown during the dry season. This may possess the advantage of providing soil cover, although a very thin one, during the dry season, but is destructive of humus and may even reduce yields by using up nitrates and moisture which would normally accumulate during the dry season. The suggestion has been made, and is practised by some cultivators on the highlands, that stubble and weeds should be buried as soon after harvest as possible in order to allow them to rot before planting time. The objection has been raised that this system might lead to nitrogen starvation of the following crop, apart from the fact that preparation of the garden at the beginning of the dry season discourages weed growth and leaves the soil comparatively bare and subject to dessication, and also leads to inhibition of bacterial activity through high temperatures and oxidation of humus. Results at Makanga in the past (1946) have indicated that maintaining the soil clean-weeded during the dry season had a deleterious effect on the crop yields as compared with mulching and leaving a cover of weeds on the plot throughout the dry season

The object of this experiment is to compare burying of crop residues with two other methods of disposal of crop residues *i.e.* (1) leaving the residues on the surface; and (2) burning, and also to investigate the effect of covering the soil during the dry season by means of a cover crop (pigeon peas) and by heavy mulching.

Design and Layout

The layout is a randomized block with six blocks each containing five plots of 216 sq. yds.

The following treatments were applied :—

(i) *Burying*

All plant refuse buried as soon after harvest as possible (June) by placing the stubble and weeds in the old furrow and splitting the ridges over them.

(ii) *Light Mulching*

Plant refuse spread on the plot as a mulch. The plot prepared in June but the refuse not buried but spread over the newly made ridges.

(iii) *Control. African Method*

Plot left undisturbed after harvest but cleared in October and all refuse burnt.

(iv) *Heavy Mulching*

Plot prepared in June and all weeds and stubble spread on the plot as mulch together with Elephant Grass (*Pennisetum purpureum*) from a plot of equal size. The mulch undisturbed at planting.

(v) *Cover Cropping*

Pigeon peas interplanted between the maize in February, harvested in October, uprooted and left on the plot.

The indicator crop is maize planted on ridges 3 ft. apart spaced 2 ft. apart in the row and thinned to two plants per hole.

Yields of maize in 1950 (lbs. dry grain per acre) were as follows :—

TABLE 19

Treatment No.	(i) ..	(ii) ..	(iii) ..	(iv) ..	(v) ..	Sig. Diff. P=0.05
Yield of maize in lbs. per acre	3,556 ..	3,561 ..	3,547 ..	3,830 ..	3,562 ..	Not significant
Percentage of Control ..	100.3 ..	100.4 ..	100 ..	108 ..	100.4 ..	Not significant

Yields of previous results expressed as percentages of the control are as follows :—

TABLE 20

Year	Uniformity Trial 1945	1946	1947	1948	1949	Mean
Treatment 1	100.9	92.6	85.3	188.2	100.3	116.6
,, 2	94.7	105.8	80.7	141.6	100.4	107.1
,, 3	100.0	100.0	100.0	100.0	100.0	100.0
,, 4	103.6	105.7	121.4	359.6	108.0	173.0
,, 5	93.96	92.3	106.7	146.8	100.4	111.5

The addition of organic matter seems to be having a slowly accumulating effect but the variation in relative behaviour from year to year, except for *heavy mulching*, which is uniformly good, indicates a seasonal effect and may therefore be connected with moisture conservation. There does appear to be a positive correlation between yields from the *buried* and *light mulched* treatments and the previous season's rainfall between July and October, but more data is required to demonstrate this positively.

AGRICULTURAL RESEARCH STATION

Chief Agricultural Research Officer	S. T. Hoyle
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Maize Variety Trial

55. This was planted on 16th December at a spacing of 4 ft.×26 ins. with three plants per hole in eight randomized blocks. A dressing of 50 lbs. sulphate of ammonia was given on 31st March. The soil was potentially good but had been in native cultivation for some years. The yields were :—

TABLE 21

Variety	*Date of Harvest*	*Yield in lb. grain per acre*
Local bulk	15th May ..	1,288
Hybrid top-cross ..	3rd May ..	1,108
90-day (*a*)	1st May ..	1,026
Kronstad Robyn ..	21st April ..	908
Hickory King	24th April ..	699
Potchefstroom Pearl ..	17th April ..	568
Anveld	17th April ..	564
American White Flint ..	17th April ..	415
Natal 8-row	17th April ..	249
Wisconsin White Dent ..	17th April ..	207
90-day (*b*)	17th April ..	187

Sig. diff. (P=.05) 282 lbs. per acre.

The general growth was not very good as the seed of the open pollenated varieties had been in store for over a year ; the 90-day (*b*) was only a 70 per cent. stand It seems evident that short term varieties were not suited to the season.

Hybrid Variety Trial

56. In this experiment ten hybrids, both single and double, were grown together with Hickory King and Salisbury White. The experiment was planted on 16th December and fertilized with 50 lbs. of sulphate of ammonia on 31st March. Nearly all the hybrids gave a higher yield than the open-pollenated varieties but the differences were not significant. The top yield of the hybrids was over 12 bags to the acre and the mean about nine bags; both considerably more than the general average on the Station.

Maize Fertilizer Trials

57. Two experiments were made, one, at the Research Station and the other at Likuni Experimental Station. Both were 3×3 designs partially confounded in blocks of nine plots. Four complete replications were used at each site. The applications used were : Sulphate of ammonia and superphosphate at nil, 100 lb. and 200 lb. per acre and muriate of potash at nil, 20 and 40 lb. per acre. All the fertilizer was applied about ten days after planting, *i.e.*, 10th to 12th December.

The principal results were in lb. grain per acre :

TABLE 22

Agricultural Research Station

	P0	P1	P2	*Mean*
N0	1,694 ..	1,698 ..	1,631 ..	1,674
N1	2,191 ..	2,499 ..	2,391 ..	2,360
N2	2,431 ..	2,660 ..	2,510 ..	2,534
Mean	2,105 ..	2,286 ..	2,177 ..	2,189

Sig. diff. for 3-way table (P=.05) 147 lbs./acre.
Sig. diff. for means table (P=.05) 85 lbs./acre.

TABLE 23

Likuni

	P0	P1	P2	*Mean*
N0	1,548	1,697 ..	1,675 ..	1,640
N1	1,845 ..	2,099 ..	2,115 ..	2,019
N2	2,255 ..	2,477 ..	2,568 ..	2,433
Mean	1,882 ..	2,091 ..	2,019 ..	2,031

Sig. diff. for 3-way table (P=.05) 201 lbs./acre.
Sig. diff. for means table (P=.05) 116 lbs./acre.

It will be seen from the above figures that nitrogen played the most important part in increasing the yield. In the experiments at the Research Station there was some falling off in increase in yield with the double dose of nitrogen, but at Likuni there was no indication that the maximum economic application of fertilizer had been reached. A dressing of 100 lbs. of super phosphate gave an increase in both cases, but a further application of 100 lbs. gave no increase. There was little sign that potash increased the yield, in fact, in some cases it appeared to decrease the yield slightly. There was an indication, however, that the use of potash reduced the lodging in maize.

A maize fertilizer experiment was carried out on an African's garden at Likuni on the same lines as the experiments done throughout the country. The land had been kept in good heart and there was no response to either sulphate of ammonia or super phosphate.

Boxing and Slope to Ridges

58. This experiment was laid down three years ago and the treatments were levelled ridges paralled to the contour bund, ridges at right angles to the contour bund, and also boxing, as opposed to no boxes. Yields for the previous two years were not recorded, but the effect on the soil, if any, was taking place during the previous seasons. The yields for this year's crop were as follows :

TABLE 24

	Boxed	*Unboxed*	*Mean*	
Sloping ridges ..	2,768	2,689	2,728	lbs. grain per acre
Level ridges	2,431	2,752	2,592	,, ,,
Mean	2,599	2,720	2,660	

The treatment differences were not significant but there was a significant interaction leading to a depression in yield when level ridges were boxed. It should be noticed that it was an exceptionally wet season when the effects of water-logging would be most marked.

Maize Fertilizer Experiment, Lisasadzi.

59. This experiment was conducted on land which had been under cultivation for three previous years. The soil here is very sandy and deficient in nitrogen as well as phosphate. The results were as follows :—

TABLE 25

	Yield per acre
100 lbs. sulphate ammonia per acre ..	1,764
100 lbs. superphosphate	1,170
100 lbs. supers + 100 lbs. sulphate ammonia ..	1,835
100 lbs. supers + 1,000 lbs. lime	1,137
Nil	1,074

Sig. diff. (P=.05) 287 lbs. per acre.

It will be seen that nitrogen was the only fertilizer which gave significant results.

Sorghum Fertilizer Experiment at Lisasadzi

60. This experiment was on the same lines as the maize experiment, but owing to shortage of suitable land, had to be done on first-year land which is not normal practice. The following table shows that the result was the same for sorghum as it was for maize, except that there was some interaction between nitrogen and phosphate.

TABLE 26

	Yield per acre
100 lbs. sulphate ammonia per acre ..	521
100 lbs. superphosphate	304
100 lbs. supers + 100 lbs. sulphate ammonia ..	684
100 lbs. supers + 1,000 lbs. lime	365
Nil	330

Sig. diff. (P=.06) 141 lbs. per acre.

Groundnut Fertilizer Experiment at Lisasadzi

61. A fertilizer experiment in the sandy soil of Kasungu District was laid out with the following treatments and results :—

TABLE 27

Treatment	*Yield per acre unshelled nuts*
(i) 100 lb. sulphate of ammonia	1,060
(ii) 100 lb. superphosphate	1,268
(iii) 100 lb. supers + 100 lbs. sulphate ammonia	1,040
(iv) 100 lb. supers + 1,000 lbs. lime ..	1,172
(v) Nil	1,172

The differences were not significant.

Fertilizer Trial on Western Tobacco at the Research Station

62. This was a 3×3 design partially confounded in blocks of nine plots, four complete replications were used. The applications of fertilizer used were sulphate of ammonia and superphosphate at 0, 100 and 200 lbs. per acre and muriate of potash at 0, 25 and 50 lbs. per acre. The whole of the fertilizer was applied shortly after the plants were established in the field. The principle results in lbs. cured leaf per acre were as follows :

TABLE 28

	P0	P1	P2	*Mean*
N0	182	208	224	205
N1	310	301	325	312
N2	369	413	463	412
Mean	287	307	334	

Sig. diff. (P=.05) 27 lbs. per acre.

Nitrogen had a marked effect and it appears that possibly more could have been applied as there was no difficulty in the curing.

The cured leaf was rough graded into four classes and the differences in yield were much magnified. The single dressing of sulphate of ammonia gave seven times as much wrapper as nil and the double dressing gave ten times as much as nil. The single dressing of supers gave a 20 per cent. increase of wrapper over no supers and the double dressing a 60 per cent. increase. There was, therefore, no doubt that the use of these two fertilizers gave an economic return in increased cash return in this season. There was no apparent advantage in the use of potash.

Flue-cured Tobacco Fertilizer Experiment at Lisasadzi

63. The treatments were exactly the same as for the Western tobacco experiment. The experiment was planted in two parts, half on second-year land and half on new land. On the second-year land the yields were as follows :

TABLE 29

	P0	P1	P2	*Mean*
N0	199	177	257	211
N1	283	252	272	269
N2	287	269	314	287
Mean	256	227	281	

Sig. diff. margins (P=.05) 25 lbs. per acre.

Once again on this Station, nitrogen is the only fertilizer which shows a significant increase in yield. The yields for the experiment were very low, largely due to a heavy incidence of *Cercospora* spot.

There was no indication that phosphate or potash improved the quality of the leaf, but in a year with so much fungus disease it is difficult to draw any firm conclusions.

In the experiment on first-year land the results were essentially the same except that the yields were rather higher and the effect of sulphate of ammonia more marked.

Fertilizer Application Experiment—Flue-cured Tobacco

64. The treatments were as follows :—

(i) 50 lbs. of tobacco mixture before planting, followed by two applications of 75 lbs. each.

(ii) 200 lbs. applied shortly after the plants were established.

(iii) 100 lbs. applied after plants were established and 100 lbs. one month later.

(NOTE.—Tobacco Mixture A was used, which contained 6 per cent. of nitrogen, 12 per cent. of $P_2 0_5$ and 8 per cent. potash.)

(iv) 200 lbs. were applied in a small hole dibbled to the side of the plant and about 3 or 4 ins. away from it. This experiment was planted in eight randomized blocks. The yields were as follows :

TABLE 30

(i)	1,185 lbs. per acre
(ii)	686 „ „ „
(iii)	888 „ „ „
(iv)	891 „ „ „

Sig. diff. (P=.05)=209 lbs. per acre.

It will be seen that there was a considerable advantage for the pre-fertilization treatment, and the lowest was the treatment where all the fertilizer was applied at once. This last result was to be expected and this treatment was included because, for reasons of simplicity, the whole of the fertilizer was applied in one application in other fertilizer experiments. The total amount of fertilizer—200 lbs. to the acre—was rather lower than what is considered to be the optimum, because it was thought that differences between treatments would be more apparent if this was done. The last treatment was a placement treatment. It would appear that there is some advantage in the fertilizer being concentrated in this way, but not so great as if applications are spread out over the whole of the growing season.

Tobacco Seed Bearing Experiment

65. A large quantity of seed has to be harvested each year for use on African Trust Land and it is of importance to ensure that the maximum yield is obtained. The standard method has been to trim the flowering head to the " crows foot " and usually to harvest and cure the leaves. A preliminary experiment was conducted using ten plants for each treatment, each plant being harvested separately, with the following results :—

TABLE 31

	Flowerhead	*Amount of leaf Left on Plant*	*Harvested*	*Yield grms. seed per Plant*
(i)	Trimmed	All	None	99
(ii)	,,	Half	Half	79
(iii)	,,	None	All	99
(iv)	Untrimmed	All	None	147
(v)	,,	Half	Half	110
(vi)	,,	None	All	127
(vii)	Plant topped in normal manner and one sucker allowed to grow.			134

Sig. diff. (P=.05) =44 grms.

The yield is greatest when the head is left untrimmed, and all leaf left on the plant. Some of the spikelets have to be cut off if the plant is to be bagged to prevent the bag bursting, but in harvesting a bulk crop it is not practicable to bag all the plants. It is interesting to note that the yield from one sucker is about as great as from the terminal shoot. The advantage of doing this is that the shape of the plant can be observed better before selection is made. There is no genetical reason why this should not be done and it would seem to be the best way of making seed selections. The leaf that was harvested was cured but the quantity was too small to draw any useful conclusions as to the economic aspect of this practice, though it did not appear to reduce the yield of seed materially.

Tobacco Seed Treatment

66. Silver nitrate is the only known efficient bacteriocide and the standard method is to soak the seed in 1 : 1,000 solution of silver nitrate in water for 15 minutes and then to wash in several changes of water before drying. It has been said that the germination is impaired if the washing is not done thoroughly. As a result of private communication from Dr. Bates of the S. Rhodesian Agricultural Department, the following experiment was conducted with varying strengths of silver nitrate.

TABLE 32

	Seed Treatment	*After treatment*	*Immediate*	*Germination percentage 6 weeks. in store*
(i)	1 :1,000 Silver Nitrate	None	92	89
(ii)	1 : 500 ,, ,,	,,	86	78
(iii)	1 : 100 ,, ,,	,,	94	92
(iv)	1 : 1,000 ,, ,,	Washed	91	92
(v)	1 : 500 ,, ,,	,,	90	91
(vi)	1 : 100 ,, ,,	,,	87	87
(vii)	Plain water		88	88
(viii)	No treatment at all		88	91

The germination was done on filter paper in petri dishes and each treatment was replicated three times. It is obvious that there are no material differences between the treatments and that washing of seed is not necessary. The unusually strong solutions were included because it is difficult to get a solution of 1 in 1,000 on an estate and it is apparent that no harm will occur if much greater strengths than normal are used.

GENERAL EXPERIMENTAL WORK OTHER THAN ON STATIONS IN THE PROTECTORATE

Officer in Charge, Southern Province — A. P. S. Forbes
,, ,, Central ,, — H. W. T. Webb
,, ,, Northern ,, — A. B. Cormack

Maize Fertilizer Observations on African Trust Land

67. A large number of African gardens were selected for observation trials on the use of artificial fertilizer. Owing to the difficulty of recording results satisfactorily, the total number eventually kept under observation during the year was 53. The results obtained with the yields expressed as a percentage of the mean at each experimental site are given in the following table :—

TABLE 33

	Mean lbs. grain per acre	100 lbs. supers per acre	100 lbs. sulphate ammonia per acre	Supers + sulphate amm.	Supers +1,000 lbs. lime	Nil
Northern Province	1,122	76	124	110	80	74
Central Province	1,736	97	115	111	97	81
Southern Province	1,399	102	107	102	93	96
Mean	1,617	95	115	110	94	82
Yield per acre		1,536	1,860	1,779	1,520	1,326

From the above it can be seen that sulphate of ammonia gave by far the greatest response of any of the fertilizers. Superphosphate gave a very moderate increase and the addition of lime to the superphosphate had no effect. There appeared to be no interaction between the superphosphate and the sulphate of ammonia. There were, however, considerable differences between Provinces and it is noteworthy that in the Northern Province, where the soils are generally less fertile than elsewhere, the response to sulphate of ammonia was greatest. In the Southern Province, on the other hand, there appeared to be very little response to sulphate of ammonia. As these trials were not replicated the results should be taken, therefore, as giving an indication only of what more careful experiments might prove.

Temperate Cereals

68. Observation plants of temperate cereals were established in different parts of the three Provinces, but only in the Vipya area of the Northern Province was a proper replicated trial area laid down. The following table summarizes the results :—

TABLE 34

GRAIN IN LBS. PER ACRE

Crop	*Control*	*Farm Yard Manure*
Oats ..	816 ..	1,392
Barley ..	1,244 ..	2,400
Rye ..	816 ..	1,732
Wheat ..	288 ..	576

It should be noted that the main treatment applied was farmyard manure and in all cases, with the exception of wheat, the temperate cereals gave a striking increased yield.

Sorghum Variety Observational Trial

69. Observational trials of different varieties of short-term sorghums were undertaken at the main centres in the sorghum-growing areas of each Province. Careful records were kept of developmental changes in the varieties, but in general the results were most disappointing, as none of the varieties yielded as well as would have been expected from their reputation in other territories.

Finger Millet Observational Trial

70. In the Northern Province, trials were undertaken with finger millet to investigate the effect of heavy applications of kraal manure on the development and yield of the crop. Applications of up to 20 tons per acre were applied and the difference in growth was most marked ; the manured plots yielded 400 per cent. on the average more than the control.

Rice

71. Observational trials were carried out in various localities but the local strain of Faya again gave the heaviest yields, with transplanting yielding better than broadcasting. In the Karonga area a replicated trial was undertaken and the results are summarized in the following table :—

TABLE 35

YIELDS IN LBS. PADDY

	Faya	*Demarara*	*Majimaji*	*Burma*	*Total*
Broadcast ..	465 ..	354 ..	510 ..	480 ..	1,789
Transplant ..	544 ..	414 ..	417 ..	213 ..	1,588
Total	989 ..	768 ..	927 ..	693 ..	3,377

Sig. Diff. between variety totals=114 lbs.

Therefore Faya and Majimaji were equal and both better than Demarara and Burma.

Demarara is better than Burma.

Observational fertilizer trials were also undertaken with sulphate of ammonia and superphosphates. The sulphate of ammonia gave a visible response in half the cases. In all areas the rice appeared to respond to superphosphate.

Coffee

72. Nurseries were established in all Provinces of both *C. arabica* and *C. robusta* in order to investigate potentialities of certain areas for the establishment of new native coffee industries in the future. Special mention is made of establishment of *C. robusta* in the Nkata Bay District of the Northern Province.

Nicotine Tobacco

73. Trials were undertaken of four varieties, namely American No. 1 and 2, Brazilian and local "*labu*" at three centres in the Southern Province and one in the Northern Province. In the Northern Province the trial was a failure, but at all three centres in the Southern Province reasonable yields were obtained of between 500–600 lbs. per acre, even though most of the plots suffered severely in the young stage by infestation of grasshoppers.

Dark Fired Tobacco

74. An experimental issue of standard tobacco fertilizer mixture was made to 60 selected growers in the Central Province. Although no accurate records could be kept, it was clear that there was a marked improvement in yield and the proportion of high grade leaf produced. The experiment caused much interest among the growers and should further supplies of fertilizer be made available, there is likely to be keen demand.

Cotton

75. Cotton variety trials were undertaken in the Northern and Southern Provinces. Eight strains supplied by the Empire Cotton Growing Corporation, Salima, were under trial against the Crown Land Land bulk from Chiromo and the Crown Land bulk produced at Karonga. In all cases the Crown Land bulk gave a highly significantly better yield than the selected strains.

Coconuts

76. Recording of the yield of established coconut trees in the Fort Johnston District of the Southern Province continued, and nurseries were established to produce selected trees for distribution to the local population.

Fibre Crops

77. *Urena lobata* and local strains of *Hibiscus cannabinus* were tried in the Northern Province, but in general were unsatisfactory. In the Southern Province, trials continued with *Corchorus capsularis* and *Corchorus olitorius* on the Lower River. The plants in general made reasonable growth and it was considered that the trials should continue.

Grasses

78. Certain burning experiments were carried out on the north Vipya. The object was to determine the effect of burning and mowing at different times of the year on the growth and vigour of the grass species, and in addition to observe whether or not the different treatments had any detrimental or advantageous effect on the vegetal cover. From a careful examination after one year the conclusion was reached that burning after the first rains, as opposed to any other burning time, gave a definite increase in the predominance of the better species. The mowing did not prove successful due, it is thought, to the fact that the cutting took place rather late after the first rains and this proved a setback rather than a stimulant.

DIVISION OF PLANT PATHOLOGY

Plant Pathologist in Charge—P. O. Wiehe

(*Report received 6th February, 1951*)

Incidence of diseases on major Crops

Tobacco

79. *Mosaic* was prevalent in the Southern Province. Particular reference should be made to two forms of the diseases which have significantly lowered the quality of cured leaves in certain cases, namely : (*a*) Vein necrosis, in which there are conspicuous brown, raised, elongated, lesions which follow the veins producing a reticuled effect or "etching". These symptoms may be accompanied by small, necrotic spots measuring up to 5 mm. diam. Vein necrosis is very conspicuous on cured leaves. (*b*) In the second case, circular yellowish spots, measuring up to 1 cm. diam. develop on the lamina. The spots coalesce, producing a regular wavy pattern of chlorotic zones. Necrosis usually accompanies these symptoms which are systematic. Infected plants may be considerably stunted. Specimens were submitted to Dr. J. C. F. Hopkins, Chief Botanist and Plant Pathologist, Southern Rhodesia who suggested that these attacks may have been caused by the cucumber mosaic virus.

Leaf Curl was more restricted in distribution than mosaic but fairly common in certain fields, causing yield reduction and marked deterioration in quality. As the leaf curl virus is only transmitted by the white fly *Bemisia*, rogueing and destruction of infected plants, as early as possible after the appearance of the first symptoms, should be strictly carried out.

Tea

80. This crop remained fairly free from serious diseases with the exception of collar crack caused by *Armillaria mellea*. Although ring-barking of woodland trees before planting, is generally practised by tea estates, there are recent cases where gardens have been established immediately after the stumping of live trees. This practice invariably leads to a greater incidence of *Armillaria* root rot. The symptoms usually appear from three to five years after planting. Bushes wilt suddenly, usually at the beginning of the growing season (*Sept.–Nov.*), presumably when the stored carbohydrates in the roots have reached a low ebb as a result of both fungal invasion and translocation to the leaves. On one estate in the Cholo District it was estimated that about 20 per cent. of the bushes died in a five-year old garden planted on an area which had not been previously ring-barked.

Tung

81. A summarized account of investigations on tung diseases is given in section dealing with "Investigations on Diseases of the Tung Trees " of this Report. Die-back caused by *Botryosphaeria ribis* was prevalent mostly in the Cholo District. It is interesting to note that this disease is less common in the Zomba and Mlanje areas. Collar rot due to *Armillaria mellea* was recorded for the first time from the Vipya.

Cotton

82. Climatic conditions prevailing during the earlier part of the year were conducive to the development of black arm (*Xanthomonas malvacearum*). Serious losses resulting from primary infection occurred in at least one area, while angular spots and die-back were very common both in the Lower Shire and Fort Johnston Districts. Areolate mildew (*Ramularia areola*) which was reported in 1949 as being of minor importance, actually caused severe defoliation in many gardens in the Lower Shire.

Maize

83. Streak (Zea virus 2) is probably the most serious disease of maize in the Protectorate. It is more widely distributed in the Southern Province than on the plateau area of the Central Province. Although no data are available on the relative yields of healthy and infected plants it would appear from field observation that significant losses occur as diseased plants are often much stunted and sterile.

Sorghum

84. Most of the varieties cultivated in African gardens are susceptible to a number of diseases which are all widely distributed (*cf.* Annual Report, 1949, and the section below dealing with " New Records of Plant Diseases "). It is believed that seed treatment with fungicidal dressings would reduce the incidence of some of the diseases. From a practical point of view, however, the use of fungicidal dusts is considerably limited under local conditions because of the dangers of poisoning.

Rice

85. Blast (*Piricularia oryzae*) was common in the Zomba District. Leaf and glume spotting caused by *Cercospora oryzae* was common in the Lake Shirwa area. With the exception of the Anglo-Eygptian Sudan, this fungus had not previously been recorded from Africa. *Phyllosticta glumarum* occurred on inflorescences at Kota Kota.

Temperate Cereals

86. The wheat varieties under cultivation are very susceptible to brown rust (*Puccinia triticana*). The disease was common on the Kirk Range and heavy infections were also observed at Mikolongwe. In the Chiradzulu area some gardens remained remarkably free from the disease. Stem rust (*Puccinia graminis*) which has been previously reported from Nyasaland (cf. Annual Report, 1938) was not seen during the year. Powdery mildew appears to be restricted to the northern part of the Northern Province (Nchenachena) where it is common and serious. Infected leaves bearing perithecia of *Erysiphe graminis* were obtained from that area. Blight of young plants (including wheat, rye, barley and oats) caused by *Helminthosporium sativum* was prevalent and resulted in serious damage to experimental plots in the Vipya.

Potato

87. In spite of repeated observations in several districts no evidence could be obtained on the occurrence of *Phytophthora infestans*. The apparent absence of this disease in the Protectorate is an interesting feature in view of its distribution in neighbouring East African territories. No attempt has yet been made to distinguish the various virus infections which affect the potato crop generally. It is interesting to note, however, that virus symptoms are more frequent in the Zomba District (altitude about 2,500 ft.) than on the Kirk Range and at Dedza (altitude about 4,000 ft.), a feature which may be relative to the distribution of insect vectors.

New Records of Diseases of Cultivated Plants

ALOE SPP.

88. (i) Rust, (*Uromyces aloes*) (Cook). P. Magn. Common on indigenous species growing wild and cultivated. In gardens, the effects of the disease can be reduced by removing and burning infected leaves before the sori break.

APPLE : (PYRUS MALUS LINN.)

(i) Die-back and canker, *Botryosphaeria ribis* Gr. & Dug. Widely distributed and causing severe die-back in certain cases (see also under *Avocado*, Grevillea, Tung).

AVOCADO: (PERSEA AMERICANA MILLS.)

(i) Die-back and canker, *Botryosphaeria ribis* Gr. & Dug. Common causing also a blight of young stems.

(ii) Algal spot, *Cephaleuros mycoidea* Karst.

BANANA : (MUSA SPP.)

(i) Anthracnose, *Glomerella cingulata* (Stonem.) Spauld & V. Schrenk. In its conidial state *Colletotrichum gloeosporioides* (Penz) Sacc.

The cause of black spots on unripe banana followed by fruit rot.

BARBERTON DAISY : (GERBERA JAMESONII HOOK)

(i) Leaf spot *Septoria gerberae* Syd. The spots have a characteristic greyish centre on which the black fruiting bodies are scattered and are surrounded by a maroon border. The disease is destructive under damp conditions, but can be controlled by spraying with a copper fungicide.

BARLEY : (HORDEUM VULGARE LINN)

(i) Blight of seedlings, leaf spot and blight of mature plants, *Helminthosporium sativum* Pamm., King and Bakke. A serious outbreak occurred on experimental plots in the Vipya.

BULLRUSH MILLET : (PENNISETUM TYPHOIDES STAPF. & HUB.)

(i) False mildew, *Beniowskia sphaeroidea* (Kalchbr. & Cooke) Mason. Fort Johnston and Lake Shirwa Districts.

(ii) Leaf Spot, *Cercospora fusimaculans* Atk. Spots nearly circular, ashy-grey with a brown border and yellow halo : often coalescing and causing blight of foliage. Fort Johnston.

(iii) Leaf spot, *Phyllachora sp.* Different from *P. penniseti Syd.* which has been collected on Napier's fodder (*P. purpureum*). Namweras.

(iv) Rust, *Puccinia penniseti* Zimm. The host range of this rust (*Vide* 1949 *R*eport) has been extended by collections on *Beckeropsis uniseta* and *Cholridion cameronii* on which hosts both uredo and teleuto phases were found.

CABBAGE : (Brassica oleracea Lin. var. bullata DC.)

(i) Black rot, *Xanthomonas campestris* (Pammel) Dowson. Isolation and inoculation of this bacterium were successfully carried out. The disease was observed in the Zomba and Ncheu Districts causing fairly severe damage.

(ii) Leaf spot, *Alternaria brassicae* (Berk) Sacc. very common, severe spotting occurring during the rains.

(iii) Leaf spot, *Alternaria brassicola* (Schw.) Wiltshire. On young plants in a private garden, Lilongwe District.

CAPE GOOSEBERRY : (Physalis peruviana Linn.)

(i) Leaf smut, *Entyloma physalidis* (Kalchbr. & Cooke) Wint. Widely distributed and causing premature defoliation.

CARNATION : (Dianthus caryophyllus L.)

(i) Leaf spot, *Septoria dianthi* Desm. Common, occurring also on stem and calyx, disfiguring plant.

(ii) Wilt, collar rot, foot rot, *Phytopthora palmivora* Bull. A troublesome disease often assuming epidemic proportions during the rainy season.

CARROT : (Daucus carota L.)

(i) Blight, *Alternaria dauci* (Kuhn.) Groves & Skolko. Controlled by spraying with copper fungicide.

CASSAVA : (Manihot utilissima)

(i) Leaf spot, *Epicoccum sp.* in association. Kirk Range (Daviko).

CAULIFLOWER : (Brassica oleracea Lin var botrytis Linn.)

(i) Black rot, *Xanthomonas campestris* (Pammel) Dowson. Common, see under cabbage.

(ii) Leaf spot, *Alternaria brassicae* (Berk). Sacc. Widely distributed.

(iii) *Virus disease* (?). Characterized by acute distortion of leaves, vein thickening, feint mosaic, stunting, and elongated necrotic lesions on stalk and midrib.

CELERY : (Apium graveolens L.)

(i) Leaf spot and blight, *Septoria apii—graveolentis* Dorogin. Common, controlled by spraying with copper fungicide.

CITRUS SPP.

(i) Die-back, *Botryodiplodia theobromae* Pat. On orange, Mlanje, Namweras.

COTTON : (Gossypium spp.)

(i) Wilt, *Fusarium equiseti* (Corda) Sacc. Port Herald District.

COWPEA : (Vigna unguiculata (L) Walp.)

(i) Leaf spot, *Cercospora cruenta* Sacc. Spots up to 1 cm. diam. orange-coloured on upper surface, reddish-brown on lower surface, often coalescing causing blight. Lower Shire (Ngabu).

(ii) Target leaf spot, *Ascochyta sp.* straw-coloured spots with distinct brown concentric zones and yellowish-green halo. Zomba, Namweras.

CUCUMBER : (Cucumis sativus Linn.)

(i) Leaf spot, *Cercospora cucurbitae* Ellis & Everh. Spots uniformly brown, more or less angular, often coalescing, causing premature defoliation.

(ii) Mosaic (?) Cucumber mosaic virus. Common, causing much stunting of plants in certain cases.

(iii) Powdery mildew, *Oidium sp.* imperfect stage of *Erysiphe cichoracearum DC* (?). Very common, causing blight particularly under dry conditions.

DAHLIA : Dahlia variabilis L.)

(i) Leaf smut, *Entyloma dahliae* Syd. Very common causing defoliation and disfiguring plant.

(ii) Leafspot, *Alternaria tenuis* Nees ex Wallr. (Group.) Causing large brown spots. Zomba District.

(iii) Mosaic (?). *Dahlia virus* 1. Zomba District.

DELPHINIUM :

(i) Wilt, collar rot, *Sclerotium rolfsii* Sacc. A destructive disease causing death of many plants, particularly during the rainy season.

EGG PLANT (Solanum melongena L.)

(i) Wilt, *Pseudomonas solanacearum* (E.F.Sm.) Dowson. Zomba District.

(ii) Leaf spot, *Alternaria solani*. (Ell. & Mart.) Sorauer. Causing blight. Zomba District.

(iii) *Aecidium sp.* (?) Aecidial stage of *Puccinia penniseti* Zimm., the bulrush millet rust. Zomba

FLAX : (Linum usitatissimum L.)

(i) Wilt, collar rot, *Sclerotium rolfsii* Sacc. Disease killing off random patches of plants in experimental beds. Cholo (Tung Exp. St.)

GERANIUM : (Pelargonium zonale Li.)

(i) Rust, *Puccinia pelargonii-zonalis* Doidge. Common, causing defoliation and disfiguring plants. Controlled by removing and burning affected leaves and spraying with copper fungicide.

GLADIOLUS SP :

(i) Rust, *Uromyces gladioli* P. Henn. Zomba District.

GREVILLEA : (G. robusta, Cunn.)

(i) Gummosis and die-back, *Botryosphaeria ribis* Gr. & Dug. Isolation pathogenic to tung and avocado. Cholo, Mlanje.

(ii) Die-back, *Botryodiplodia theobromae* Pat.

GUAVA : (Psidium guajava L.)

(i) Die-back, *Botryosphaeria ribis* Gr. & Dug. Isolations pathogenic to tung and avocado. Zomba District.

HYDRANGEA SP :

(i) Leaf spot, *Cercospora hydrangeana* Thorp., with *Mycosphaerella sp.* in association. Spots somewhat angular, brown, surrounded by a purplish margin up to 2×1 cm. Often coalescing causing blight. Cholo District.

JUTE : (Corchorus capsularis L & C. olitorius L.)

(i) Blight, *Cercospora olitorius* Sawada. Lower Shire, in experimental plots at Makanga. A disease causing blight of foliage and stems, conidia of the fungus being present on the latter. *Corchorus capsularis* appears to be considerably more resistant to the disease under conditions prevailing at the experimental centre.

KALE : (Brassica oleracea L. var. acephala DC.)

(i) Leaf spot, *Alternaira brassicola* (Schw.) Wiltshire. Spot similar to those developing on cabbage.

LEEK : (Allium porrum L.)

(i) Leaf spot and blight. *Alternaria tenuissima* (Ness ex Fries) Wiltshire (group). Spots elliptical and watersoaked at first, occurring chiefly near apex of leaves. The spots enlarge rapidly, turn brown, killing off the leaves.

LETTUCE : (Lactuca sativa L.)

(i) Leaf spot, *Cercospora longissima* (Cug) Sacc. Common, some varieties (" cabbage lettuce ") appear more susceptible, but as a rule the spots only occur on outer leaves.

LUFFA : (Luffa cylindrica (Lour.) Roem.)

(i) Fruit spot, *Mycosphaerella citrullina* (C.O. Smith) Gross. Spots circular, zoned, up to 4 cms. diam., reddish-brown at first, turning to dark-brown. Common on fruits nearing maturity, causing blackish-brown stains on the " sponge " and reducing their market value. Zomba District.

(ii) Mildew, *Oidium sp.* Oidial stage of (?) *Erysiphe cichoracearum DC.*

LUPIN : (Lupninus spp.)

(i) Leaf spot, *Cercospora canescens* Ell. & Mart. Disfiguring plants and causing blight of foliage in damp weather.

(ii) Wilt, collar rot, *Sclerotium rolfsii* Sacc., Zomba and Cholo Districts.

MAIZE : (Zea mays L.)

(i) Leaf spot, *Diplodia macrospora* Earle. Spots elliptical at first, then forming stripes, straw-coloured with dark-brown margins and yellow halo. Lilongwe District.

MANGO : (Mangifera indica L.)

(i) Mildew, *Oidium mangiferae* Berthet. A common and destructive disease which may cause complete blight of flowers and new foliage significantly reducing the fruit crop.

MULBERRY : (morus nigra l.)

(i) Mildew, *Phyllactinea corylea* (Pers) Karst. Zomba District.

NASTURTIUM : (Tropaeolum majus L.)

(i) Mildew, *Leveillula taurica* (Lev) Arh. Common, causing defoliation.

OAT : (Avena sativa L.)

(i) Blight of seedlings, *Helminthosporium sativum* Pamm., & King & Bakke. Young leaves show elliptical light-brown, watersoaked spots, the outer leaves turn yellow, and death of the seedling often results. Vipya experimental plots.

(ii) Leaf spot, *Mycosphaerella sp.* in association, Vipya Experimental plots. The spots are brownish-black, elongated and occur on blades, sheaths and glumes with numerous perithecia scattered on the dead tissues.

OKRA : (Hibiscus esculentus L.)

(i) Leaf spot, *Cercospora hibisci* Tracy & Earle. Forming angular greyish-black spots, which may occur densely scattered on the leaf surface causing defoliation.

(ii) Mildew, *Oidium sp.* Oidial stage of (?) *Erysiphe cichoracearum DC.*, causing blight of foliage, also occurs on stems and fruits.

ONION : (Allium cepa L.)

(i) Blight, *Colletotrichum capsici* (Syd.) Butler & Bisby (group). On leaves. Spots watersoaked at first, turning to greyish-black. Elliptical, elongating rapidly causing collapse of leaves at ground level. Central Province (Chitala).

PAWPAW: (Carica papaya L.)

(i) Leaf spot, *Cercospora sp.* Brown spots roughly circular up to 2 cms. diam. Fort Johnston.

(ii) Mildew, *Ovulariopsis papayae* van der Bijl. Common, often causing blight of leaves.

(iii) (?) *Virus disease*, characterized by yellowish-green mottling on a dark-green background, puckering, marked reduction in size of leaves, death of growing point followed by production of numerous suckers which exhibit the above symptoms. Mwanza District.

PEA : (Pisum sativum)

(i) Leaf spot and blight, *Ascochyta pisi* Lib. Common, causing serious blight during the rainy season.

(ii) Mildew, *Erysiphe polygoni DC.* Widely distributed, reducing yields significantly. The perfect state of the fungus was collected on one occasion (No. 858. Dedza District. alt. about 4,500 ft.).

PEACH : (Prunus persica Stockes.)

(i) Die-back, *Cystospora sp.* Causing death of large branches, Dedza District.

(ii) Leaf curl, *Exoascus deformans* Tub. Observed at Zomba, Dedza, Limbe, may cause severe defoliation on young shoots.

(iii) Rust, *Puccinia pruni-spinosae* Pers. Very common, only seen on leaves. Often producing a shot-hole effect. This rust has also been observed on apricot (*P. armeniaca L.*) and plum (*P. domestica L.*).

PETUNIA : (Petunia violacea Lindl.)

(i) Leaf spot, *Cercospora petuniae* Muller & Chipp. Spots circular straw coloured with white centre. Disfiguring plants.

(ii) Mildew, *Oidium sp.* (Oidial stage of (?) *Erysiphe cichoracearum DC.*

PHLOX : (Phlox drummondi.)

(i) Leaf spot, *Septoria drummondii* Ell & Ev. Spots up to 1 cm. diam. light brown with raised margins and yellow halo. Affected leaves turn yellow and fall prematurely.

RADISH : (Raphanus sativus L.)

(i) Leaf spot, *Alternaria brassicae* (Berk.) Sacc. On plants kept for seed.

(ii) Powder mildew *Oidum sp.* Common on plants allowed to seed.

RICE : (Oryza sativa L.)

(i) Glume spot, *Phyllosticta glumarum* Sacc., inhibits development of grains. Kota-Kota.

(ii) Glume spot, *Eusarium sp.*, Lake Shirwa.

(iii) Leaf spot, *Cercospora oryzae* Miyake. Spots elliptical up to 7×3 mm., ashy grey centre with reddish border. Coalescing causing blight.

ROSE : (Rosa spp.)

(i) Leaf spot, *Diplocarpon rosae* Wolf. Disfiguring leaves.

(ii) Mildew, Oidial stage of *Sphaerotheca pannosa* (Wallr.) Lev. Common and causing serious damage during the dry season. Controlled by lime-sulphur spray.

ROSELLE : (Hibiscus sabdariffa L.)

(i) Leaf spot, *Alternaria macrospora* Zimm., causing blight of leaves, the fungus may also penetrate the stem resulting in die-back. Mwanza District.

(ii) Mildew, *Oidium sp.* Oidial stage of (?) *Erisyphe cichoracearum DC.*

RYE : (Secale cereale L.)

(i) Blight of seedlings *Helminthosporium sativum* Pamm., King & Bakke. Vipya Experimental plots.

SIMSIM : (SESAMUM INDICUM L.)

(i) Leaf spot, *Cercospora sp.* (Not *C. sesami* Zimm.) Spots angular, greyish centre with dark coloured margins, causing defoliation. Central Province (Chitala).

SPINACH BEET : (BETA VULGARIS L. VAR CICLA L.)

(i) Leaf spot, *Cercospora beticola* Sacc. Common.

SPINACH. New Zealand. (TETRAGONUS EXPANSA MURR.)

(i) Leaf spot, *Cercospora tetragoniae* Speg.

SORGHUM (SORGHUM VULGARE PERS.)

(i) Glume spot, *Phoma insidiosa* Tassi, marked varietal resistance and susceptibility ; Central Province, (Chitala).

(ii) Glume spot, *Mycosphaerella sp.*, not *M. ceres* Sacc. and resembling the species occurring in association with leaf spot of oats.

(iii) Leaf spot, probably *Gibberella zeae* (Schw.) Petch. Spots elliptical and brightly coloured. Up to 5 cms. long $\times$ 8 mm. broad. Greyish centre surrounded by red border and yellow halo. The spots often coalesce causing blight. There appears to be a marked varietal susceptibility. Zomba District ; Namweras.

(iv) Leaf spot, *Cercospora sorghi* Ell. & Everh. Spots roughly circular up to 1 cm. diam., ashy-grey centre with maroon border. Heavy spotting may be accompanied by a conspicuous red discoloration of tissues preceding death of leaves. Lower Shire (Ngabu).

(v) Spot of leaf sheath, *Cercospora* (?) *vaginae* Kruger. Spots elliptical, dark reddish-brown with sunken dark centre. Infection passes from one leaf sheath to the next eventually reaching the stem. Zomba District.

(vi) Spot of midrib, *Didymosphaeria sp.* Spots start as red elliptical dots, which enlarge rapidly extending along most of midrib ; straw coloured with reddish-brown margins and perithecia scattered on the surface. Namweras.

SWEET PEA : (LATHYRUS ODORATUS L.)

(i) Leaf spot, *Cercospora canescens* Ell & Mart. Spots circular to elliptical, forming large blotches on leaves. Affected leaves become chlorotic and are often attacked by *Cladosporium sp.* Cholo District.

(ii) Mildew, *Oidium sp.*, Oidial stage of (?) *Erysiphe polygoni DC.*

SWEET PEPPER : (CAPSICUM ANNUM L.)

(i) Fruit spot, *Alternaria tenuis* Nees ex Wallr. (group). Brown nearly circular spots at first, enlarging rapidly becoming sunken with raised reddish-brown margins. Infected fruits shrivel and drop. Lower Shire (Chiromo).

(ii) Leaf spot, *Cercospora capsici* Heald & Wolf. Circular, light coloured spots which often coalesce. Mwanza District.

TOBACCO : (NICOTIANA TABACUM L.)

(i) Leaf spot, *Septomyxa affinis* (Sherb.) Wr. Light brown, zonate spots up to 8 mm. diam., sometimes coalescing. Marked ringed effect with necrotic zones surrounding green centre. Only observed on seedling plants in nursery beds. Common.

(ii) Mosaic, Vein necrosis, (?) *Cucumber Mosaic virus.* Conspicuous brown, raised elongated lesions following the veins and producing a reticulated effect. Disease widespread on one estate in the Limbe District, lowering significantly the quality of cured leaves.

(iii) Rosette, (?) *Rosette virus* Wickens, 1938. Diagnosis on symptoms only. Causing much puckering, distortion of leaves, curling and thickening of veins, but no errations. Shortened internodes, necrosis of vascular strands at base of midrib and in stem. Zomba District.

(iv) (?) Virus disease. Circular, yellowish spots up to 5 mms. diam., coalescing and producing a wavy pattern which is more conspicuous along veins. Systematic infection. Causing significant stunting. Widespread on one estate in Limbe District.

TOMATO : (LYCOPERSICUM ESCULENTUM MILL.)

(i) Blossom end rot, physiological. Common, controlled by regular water supply and mulching.

(ii) Leaf spot and blight, *Alternaria solani* (Ell. & Mart.) Sorauer. The disease is aggravated by wet conditions, but may be controlled by successive sprayings with copper fungicides.

(iii) Leaf spot, *Cladosporium fulvum Cooke.* A destructive disease during the rainy season. Controlled by spraying with copper fungicide.

(iv) Leaf spot, *Septoria Lycopersici* Speg. May cause heavy spotting with consequent blight of foliage.

(v) Bronzing (?) Virus. Conspicuous discoloration of foliage, light purple veins and margins on chlorotic background. Leaves are thick, brittle, distorted, the margins folded upwards. Necrotic spots which begin as watersoaked circular areas present on leaves, Ncheu District.

TUNG : (ALEURITES MONTANA FORSK.)

(i) Collar rot of seedlings, *Fusarium sp.* in association. Occurring in an epidemic form on transplanted seedlings at the Tung Station.

(ii) Deficiency diseases. Although investigations on deficiency diseases are being conducted by the Tung Analytical Chemist the following record of types of symptoms (excluding Zinc deficiency symptoms) probably associated with malnutrition are given below :

(*a*) " Interveinal spotting. Spots brownish-black with a yellow halo, angular, from 1 to 5 mm. corky on the lower surface. Densely scattered in a regular patern on the mesophyll area between the veins. Leaves usually chlorotic, symptoms on most of the foliage. Zomba, Cholo.

(*b*) " Marginal corrosion ". Conspicuous marginal necrosis of the leaf blade sometimes accompanied by occasional dark brown spots on which weak parasites develop (*Cladosporium sp., Alternaria sp.*) Necrosis sets in at an early stage, usually from three to six weeks after leaves have unfolded. Trees usually stunted, with yellowish-green foliage due to interveinal chlorosis. Cholo.

(*c*) " Silvery spot ". Spots regularly scattered between veins, pinhead size and dark brown at first, becoming angular, corky on the under surface and silvery on the upper surface. Foliage not chlorotic. Zomba District.

(*d*) " Interveinal Bronzing ". Mesophyll area turn reddish-brown, then bronze colour, the discoloured region being clearly defined by the veins. Cholo District.

(*e*) " Translucent spotting ". Spots densely and regularly scattered, roughly circular up to 4 mm. diam. Dark brown with conspicuous yellow halo. In the early stages the spots show a watersoaking effect and are almost translucent. Zomba and Cholo Districts.

(iii) Die-back, *Botryosphaeria ribis* Gr. & Dug., The cause of this disease was definitely established from collections and cultures including the perfect and imperfect (*Dothiorella gregaria* Sacc). states of the fungus.

(iv) Leaf spot, *Mycosphaerella sp. nom.* (*Cercospora* sp. in the imperfect state). Spots roughly circular, feintly zoned, brown with a greyish-white centre and broad yellowish, watersoaked halo. Under damp conditions the spots enlarge rapidly, coalesce causing decay of the leaf blade. Conidia amphigenous, perithecia of *Mycosphaerella* on under surface. The connection between *Mycosphaerella* and *Cercospora* was established by inoculating cultures derived from ascospores and obtaining *Cercospora* fructifications on the spots developing after inoculation. The pathogen concerned is different from *Mycophaerella aleuritides* (Miy.). (*Cercospora aleuritides* Miy. in the imperfect state) which is reported on *Aleurites fordii* in China and Brazil*.

(v) Leaf spot, Algal spot, *Cephaleuros mycoidea* Karst. Common but probably of minor importance.

(vi) Leaf spot, *Pestalotiopsis* (?) *japonica* Steyaer. Spots dark brown with broad orange-yellow halo. Cholo, Zomba Districts.

(vii) Sunscorch. The commonest fungus found in association with sunscorch of the bark is *Botryodiplodia theobromae* Pat., the attack being usually accompanied by a profuse gummy exudation. Although *Botryosphaeria ribis* Gr. & Dug. is often associated with the disease as reported in 1949, the former species appears to be more widely distributed. *Schizophyllum commune* Fries. is another species of common occurrence on sunscorched branches, causing a dry rot of the wood. Finally, an unidentified species of *Polyporaceae* caused serious wood decay on one estate where sunscorch is prevalent.

(viii) Twig blight, *Botryodiplodia theobromae* Pat. Common in the spring months causing die-back of the first or second lateral shoot below the old fruit stalks.

(ix) Wind damage. The foliage of *A. montana* appears to be particularly susceptible to wind damage which may take several forms :

(*a*) Leaf shredding, leaf shattering. Initiated by slight friction between leaf blade and old fruit stalks or stems, causing first, a watersoaked spotting which turns necrotic and forms a focus along which the blade tears readily during windy weather. Weak parasites often aggravate the original lesions (*Alternaria sp., Pestalotia sp., Colletotrichum sp.*)

(*b*) Broken petioles. The petioles bend over but do not break off, near the axils. The epidermis dies at the point of bending, the leaves hang down vertically and wilt. Very common locally on young foliage during windy weather.

* I am grateful to Dr. M. B. Ellis for the examination of these specimens and pointing out that the fungus concerned does not agree with *M. aleuritides*.

VELVET BEAN : (Mucuna aterrima Holland)

(i) Leaf spot, *Cercospora stizolobii* Syd. Spots greyish-brown up to 5 mms. diam., densely scattered over leaf surface. Zomba.

(ii) Pod spot, *Gloeosporium sp.* Spots circular, sunken, dark brown with buff coloured acevulii arranged concetrically. Neno District.

(iii) Rust, *Uromyces mucunae* Rabenh. Common, occurring also on wild *Mucuna spp.* including *Mucuna pruriens* (Cowitch).

VERBENA : (Verbena spp.)

(i) Powdery mildew, *Oidium sp.* Common and causing blight during dry weather.

VINE : (Vitis vinifera L.)

(i) Leaf spot, *Alternaria tenuissima* (Fr.) Wiltshire. Causing large angular brown blotches on leaves. Blantyre.

VIOLET : (Viola odorata L.)

(i) Leaf spot, *Cercospora violae* Sacc. Spots with greyish white centre and brown-border. Petioles often attacked causing collapse of leaves. Common in damp weather.

WATER MELON : (Citrullus vulgaris Schrad.)

(i) Leaf spot, *Cercospora citrullina* Cooke. Angular brown spot with greyish-white centre. Lower Shire (Msenje).

WHEAT : (Triticum vulgare L.)

(i) Blight of seedlings, *Helminthosporium sativum* Pamm., King & Bakke.

Vipya Experimental plots. Light brown, watersoaked spots on young leaves, not visible on older leaves. Fungus penetrates the stem bringing about death of seedlings in random patches.

(ii) Leaf spot, *Septoria nedorum* Berk. Causing elongated brown spots on leaf blades and sheaths. Vipya Experimental Plots.

ZINNIA : (Z. ELEGANS LINN.)

(i) Leaf spot, *Cercospora zinniae* Ell. & Mart. Common, causing circular brown spots with ashy-grey centre, disfiguring plants.

(ii) Virus disease characterized by the following symptoms : plants stunted, leaves chlorotic, elongated with margins rolled inwards. Veins thicked, anastomosing causing considerable distortion in some cases. " Petals " ruffled or fluted, producing an asterlike flower head. Veins of " petals " much thickened. Zomba.

(iii) Wilt, *Pseudomonas solanacearum.* (E.F. Sm.) Dowson.

Investigations on Diseases of the Tung Trees

89. Investigations on diseases of *Aleurites montana* again represented the major activity of the division during the year. The work included laboratory studies as well as field experiments, the latter carried out in close collaboration with the Agricultural Officer, Tung Station, to whom the writer is greatly indebted for many facilities. A full account of these investigations will be published during the year, so that it is only necessary to record in this Report a summary of the results obtained.

Botryosphaeria Die-back

(i) *Cause of the Disease*

90. With the assistance of the Mycological Institute, the identity of the fungus causing die-back was definitely established to be *Botryosphaeria ribis* Gr. & Dug. Typical stromata containing the pycnidial state of the fungus *Dothiorella gregaria* Sacc. were repeatedly obtained on the bark of recently killed shoots and in cultures on sterile twigs. Similarly, the perfect state of the fungus was also collected and material exhibiting development of asci and pycnospores in the same stroma was secured in one instance.

Spore dimensions based on 100 measurements from ten different collections were found to average 13–25×6–10 (19×7) microns for ascospores and 8–24×3–7 (14×4) microns for pycnospores.

Germination and viability tests of *Dothiorella* spores were determined in relation to the life cycle of the organism on tung. The results obtained so far, show that although percentage germination of the spores decreases after a period of about four months, a large proportion of the spores are viable after a period of ten months.

The relationship of pathogenicity to chromogenesis of the fungus in culture was studied in 21 isolates which had reacted positively on inoculation. Cultures were established on corn meal agar and after six days' growth, colouration of the media, if present was determined on Munsell's standard colour charts. It was found that three cultures were non-chromogenic, the others producing a colour reaction varying from greenish-to reddish-yellow. These results are at variance with those of other workers as they show that pathogenicity of *Botryosphaeria ribis* is not always related to chromogenesis (*cf.* Shear, Clements, Wilcox in *Journal of Agricultural Research*, 27, 589–598, 1924).

In addition to *Aleurites montana* and *A. fordii*, the host range of *Botryosphaeria ribis* in Nyasaland now includes apple, avocado pear, guava and *Grevillea robusta.*

(ii) *Mode of Infection*

It has been previously reported that the fungus may gain entry into branches in a variety of ways such as wounds, apical buds, previous season's fruit stalks or immature fruits. Furthermore, data obtained in 1949, indicated that one of the commonest types of primary infection appeared to be related to the presence of old fruit stalks on the shoots. With a view to obtaining more evidence on peduncular infection, several experiments were carried out. They are briefly described below and indicate certain interesting features in the life history of the organism on tung.

(*a*) Healthy twigs bearing fruit clusters were labelled serially just before fruit fall towards the end of May. Observations on their subsequent history was made at intervals thereafter. Of the 50 selected twigs, 10 had shown typical blight of the current season's shoot at the end of December. In all cases infection proceeded from the peduncles as revealed by the presence of fruiting bodies of *Dothiorella* on the twig and the absence of infected tissues in the wilting lateral shoot. It is worth recording that blight of shoots took place within a fairly narrow period of approximately six weeks beginning three months after fruit fall. Incidence of the disease occurred approximately at the same time in all cases.

(*b*) Soon after fruit fall in the last week of June, 41 fruit twigs bearing a total of 190 fruit stalks were removed at random from a group of four trees which had shown *Botryosphaeria* infection the previous year. They were examined in the laboratory and the development of abscission layers in relation to fungal invasion of peduncles and twigs was studied. Isolations made from 33 peduncles and 11 twigs which showed brown strands in the vascular tissue yielded the following fungi in culture : *Pestalotia spp.* (14), *Botryosphaeria ribis* (13), *Botryodiplodia theobromae* (8), *Fusarium sp.* (1). Ten cultures were negative. It appears from these results that several species of fungi normally develop on sesescent fruit twigs, but while some of these are saprophytes or weak parasites, others such as *Botryosphaeria ribis* and *Botryodiplodia theobromae* may progress down the stem causing a die-back of newly formed shoots.

(*c*) In order to determine if infection arising from fruit stalks is in any way connected with presence of the fungus in or on the fruit before fruit fall, a large number of cultures was made from fruits sampled at intervals, starting from the moment pollination had taken place. This series of investigation is still in progress but positive evidence has already been obtained on the presence of spores of *Dothiorella gregaria* on the fruit surface, more particularly in the region of the perianth scar.

(iii *Control Measures*

In view of the incomplete knowledge of the life cycle of the fungus and of suitable spraying or dusting machinery, experimental work on the control of die-back was restricted to pruning out diseased wood and recording the effect of this treatment in conjunction with several wound dressings formulated by the Tung Chemist. These experiments are reviewed by the Agricultural Officer, Tung Experimental Station, in his Report (*cf.* paragraphs 18–21.)

Sunscorch

91. Sunscorch is a common and serious affection of tung trees in Nyasaland. It is common on recently budded plants when the bark becomes suddenly exposed after removal of the stock branches.

With a view to determining factors affecting the onset of the disease and possible control measures, the following treatments were included in two experiments comprising an aggregate of 72 trees.

Main treatments

A. Trunk unshaded, by removing stock branches three weeks after budding.
B. Trunk shaded, *i.e.* stock branches not removed.
C. Trunk shaded to the NW. by removing branches on the SE. three weeks after budding.
D. Trunk shaded to the SE. by removing branches on the NW. three weeks after budding.

Sub-treatments

(*a*) trunk white-washed,
(*b*) trunk protected with straw,
(*c*) no treatment.

The results obtained showed conclusively that :—

(i) Under favourable climatic conditions (hot and dry), the bark is quickly affected by the sun's rays, distinct lesions being visible as early as seven days after shade removal.

(ii) The lesions develop only on the NW. side of the trunk.

(iii) Artificial protection of the bark by straw or lime-wash prevents the development of sunscorch. In the former case an insecticide should be incorporated in the straw so as to prevent termite attacks. Lime-washing should be repeated at intervals during a period of about three months when the shade produced by the scion's growth should be sufficient to prevent scorching of the bark.

(iv) In the majority of sunscorch cases parasitic fungi gain entry through the dead bark and may cause rapid rotting of the wood followed by death of the tree. The following species are of special importance in this connection : *Botriodiplodia theobromae* Pat., the presence of which is accompanied by a profuse gummy exudate ; *Botryosphaeria ribis* Gr. & Dug. causing a brown rot of the wood ; *Schizophyllum commune* Fr. associated with a spongy rot of the affected part.

Miscellaneous

92. (i) The following legislation relating to plant protection was enacted during the year:

(*a*) Government Notice 13, revising the conditions under which tea seeds may be imported into the Protectorate.

(*b*) Government Notices 195, 206, relating to the importation of tomato seed.

(*c*) Government Notice 200 modifying G.N. 242 of 1949 to prevent the importation of sunflower seeds from certain countries.

(ii) Five hundred and one specimens of diseases were examined including a number of new records for the Protectorate, the more important of which are listed in "*New Records of Plant Diseases*" section above ; 84 days were spent in the field, but it was unfortunately not possible to visit the Northern Province. Talks on plant diseases were given to the Tung Association, Native Tobacco Board and Zomba Garden Club.

(iii) In addition to the mycological herbarium which now comprises over 700 specimens of plant diseases, a herbarium of flowering plants was started in 1949 with special emphasis on the *Gramineae*. Five hundred and twenty-six accessions were made to the grass collection, comprising 255 species and including 135 specimens presented by Mr. E. Lawrence.

iv) A few weeks were spent in Southern Rhodesia during the earlier part of the year. The valuable assistance received from Drs. J. C. Hopkins, G. R. Bates and H. Wild, who have also examined diseased specimens and host plants on various occasions is gratefully acknowledged.

(v) Duplicates of most of the plant disease specimens collected were submitted to the Commonwealth Mycological Institute and the writer is greatly indebted to the Director and his staff for their assistance in the identification of pathogens. Similarly, his thanks are due to the Director of Kew Herbarium and his staff in the identification of flowering plants.

DIVISION OF ENTOMOLOGY

Entomologist in Charge : Michael H. Breese.

93. The main work of the Entomological Divison during the year was in connection with the study and control of the pests of cotton and stored products.

94. The "Non-cotton Year" experiment at Makanga unfortunately failed in its main purpose which was to demonstrate the behaviour of the Lower River cotton in the absence of severe red bollworm attack, but records of crop production and insect infestation of the experimental plots were continued throughout the growing season.

Crop Pests

95. Although several crop pests caused significant damage in localized areas of the Protectorate during the year, in no case did such attack constitute a major outbreak, with the notable exception of Red Bollworm on cotton.

Maize

96. In January an outbreak of army worm (*Laphygma exempta*. Wlk.) in the Henga Valley caused considerable damage to young maize and necessitated replanting in many areas. There was a rapid diminution in the severity of the attack at the end of the month when the larvae were simultaneously preyed upon by flocks of unidentified migratory birds and locally by *Carabid* larvae.

Except for a localized attack in late sown sweet maize there were no reports of undue damage by the maize stalk-borer *Busseola fusca*. Hmps.

Rice

97. Rice planted early in January on the Limpasa dambo was attacked towards the end of the month by the *Ephydrid* fly, *Hydrellia sp*. Overall infestation of seedlings was about 50 per cent. but in the wetter areas there was a 100 per cent. plant infestation.

The minute larvae enter the tip of the young leaves and proceed downwards consuming the mesophyll tissues. Where the attack is mild, outer leaves only are affected, but in cases of serious attack all leaves are affected and extensive leaf mining causes the death of the seedling. Pupation occurs in the leaf blade ; no penetration into the leaf-base or the stalk was observed.

By the beginning of March there was a high incidence of parasitism by a *Eulophid*, genus near *Olynx*, and the crop was able to grow away from the attack.

Coffee

98. At the Nchenachena Coffee Station the number of larvae of *Anthores leuconotus*, revealed by bark rubbing reached a marked peak in May, followed by an equally rapid fall in June. It is possible that in the earlier months of the year, larvae are so small as to escape detection by the African Staff. The diminution in numbers found in June is probably due to larvae having entered the main stem. The importance of continuing bark rubbing until the end of May at least, is thus underlined.

Cotton

99. The prohibition of cotton-growing enforced during 1949 was maintained in the area of five miles radius centered on the Makanga Experimental Station. Plots of cotton in pure stand and interplanted in maize were, however, grown by the Department of Agriculture at Makanga and it was hoped that as a result of the previous year's prohibition and the maintenance of the quarantine zone the behaviour of the crop could be studied in the absence of severe red bollworm (*Diparopsis castanea*, Hmps.) attack, and yields compared with those of similar plots planted as controls in native gardens outside the quarantine area. Other small plots of pure stand cotton were planted at one mile intervals along two radii extending north and east from Makanga, the purpose of these being to give an indication of the rate of invasion of the quarantine area by *Diparopsis* moths from adjacent cotton. None of the information required was obtained. Eggs were found on 19th January on cotton planted at Makanga on 4th December and by the end of the month eggs could be found on the majority of radial and central plots indicating the presence of female moths throughout the north-eastern portion of the quarantine area. A distance of five miles is, therefore, well within the flight range of the moth.

With the exception of certain plots planted in early December, most cotton was planted during the first ten days of January. The fact that eggs were found on the plants so soon after their germination suggests that gravid females were in the quarantine area possibly before any cotton had been sown and supports the suggestion made by *Pearson and Mitchell that moths tend to disperse rapidly from the place where they emerge.

Bollworm attack was more severe within than outside the quarantine area and of the bolls that survived to maturity in experimental and control plots, only in one (pure stand) did more than 10 per cent. produce clean cotton. The proportion destroyed by bollworm varied between 27 and 54 per cent.

The termite *Hodotermes mossambicus*, Hagen, caused appreciable loss of stand in the Ngabu area of the Lower River during the early part of the year.

In May, cotton-growing on the Palombe Plain suffered a severe attack of American bollworm, *Heliothis obsoleta*, F. The attack was, however, of short duration and did not seriously depress the expected yield.

Flowering Shrubs, Trees and Timber

100. Oleanders, Gardenia and a few Bougainvillea bushes in a garden on the shores of the southern end of Lake Nyasa were attacked by a Lamiid beetle, probably *Sthenias cylindrator*, F. Shoots of up to 1 in. in diameter are deeply ringed but not completely severed and when the dead wood has reached the requisite state of dryness, eggs are laid in it. Oviposition sites are marked by small transverse slits in the bark and eggs are laid singly in a small cavity extending longitudenally beneath the bark from the slit. Larvae, on hatching, bore down into the pith and work along it. Later instars attack the wood leaving only a shell of bark into which the fine powdery frass is tightly packed. Frass may also be ejected from small holes made at intervals along a shoot. Eggs and first instar larvae were collected at the end of May but only one adult had emerged by 17th January, 1951. In December, however, seven fourth instar larvae were removed from a piece of shoot 8 ins. long and less than half an inch in diameter.

*E. O. Pearson and B. L. Mitchell. *A Report on the Status and Control of Insect Pests of Cotton in the Lower River Districts of Nyasaland.* 1945, Zomba, Government Printer.

A severe infestation of *Cedrella toona* by an unidentified *Lamiid* beetle was reported from Dowa in the Central Province. The trees had been debilitated by drought and the beetles were probably attracted initially to dying branches. Emergence of adults began in December and, so to avoid a possible spread of pest, severely infested branches were removed and burnt. Badly attacked trees were felled and barked after the removal of the infested branches.

Beans : (Phaseolus vulgaris)

101. An experiment was carried out at the Zomba Investigational Farm on the control of the bean fly, *Melanagromyza phaseoli*, Coq. with 5 per cent. D.D.T. and 5 per cent B.H.C. dusts. Canadian Wonder beans were planted in mid-December and dusted at weekly intervals.

Dusting began 14 days after planting and continued for a period of two months. Unfortunately, the effect of the treatments could not be assessed as during this time damage caused by bean fly on dusted and control plots was negligible, although a severe attack causing 70 per cent. plant infestation was reported in the same period from beans grown on ground long fallow under bush in the Blantyre District.

Death of 2 per cent. of the plants was, however, caused in all experimental plots by the gall-forming weevil *Alcides leucogrammus*, Er. Untreated beans sown later in the season on the Zomba Investigational Farm showed a progressive increase in the degree of bean-fly attack, there being an almost 100 per cent. loss in those sown towards the end of March.

Groundnuts : (Arachis hypogea)

102. Caterpillars of the *Pyralid* moth *Maruca testulalis*, Geyer. were reported in considerable numbers on groundnuts in the Lilongwe District in February. Damage was confined mainly to young leaves and growing points, and there was also a certain amount of burrowing into stalks, but seldom did the death of the plants result.

Tobacco

103. Damage to newly planted tobacco caused by *Jullid millepedes* was widespread in the Southern Province during January and early February and much loss of stand was suffered in all tobacco areas. Hand collecting where assiduously practised exerted a definite control and permitted the establishment of supplies.

In December, seedbeds on an estate near Zomba were treated experimentally with Shell " DD " used at the rate of 500 and 700 lbs. per acre. Estimation of the number of galled seedlings in treated beds did not proved possible but the vigour and evenness of growth in treated beds as compared with untreated beds was marked.

Sections of fields where eelworm damage had been most prevalent in previous years were also chosen for " DD " treatment. The fumigant was injected at the planting stations at the rate of 10 ccs. per injection, *i.e.* the equivalent of approximately 150 lbs. per acre. The results of the field treatment will be published in the Entomologist's Report for 1951.

Two reports of infestation by the Stored Tobacco Beetle *Lasioderma serricorne* F. in tobacco offered for sale over the Auction Floors, were confirmed in May. Investigation indicated that the infestation had probably arisen initially in tobacco carried over from the previous season.

The necessity for a regular and thorough clean-up in grading sheds and bulk stores is still not fully appreciated, and in both of the cases investigated infested scrap tobacco was found lying about in sheds in which leaf from the current year's crop was being graded.

Tung : (Aleurites montana)

104. The *Tenebrionid* beetle *Himatismus* (?) *patruelis*, Bates, was found making small galleries in the wood of two- to-three-year old branches of tung on an estate in the Mlanje District. Although the entrance holes of the galleries were occluded with gum, adult beetles were extracted alive.

In past experience *Bostrichid* borers which have been found in tung have been killed by the rapid gum formation which occurs in the wound. The extraction of live *Tenebrionid* adults is therefore of particular interest.

Stored Products

105. Monthly inspections were made from August onwards of stocks of bagged maize held by the Maize Control Board. These inspections revealed a remarkable build-up of infestation by *Calandra oryzae*, in grain which had originally been classified as clean. Bags were dusted with 5 per cent. D.D.T. dust as laid, and stack exteriors were liberally dusted at two to three-weekly intervals. The main store was new and had held no form of grain product previously. There is every reason to believe that infestation had arisen in the field or during the early stages of handling, but the larvae in the grain at the initial examination were not revealed by the ordinary methods of infestation assessment in use in the laboratory. The " Carbon Dioxide Method " for estimation of infestation in grain has now been adopted and will in future give a much more accurate indication of the keeping qualities of new grain.

A grain-pit of the type in common use for long-term storage in the Argentine was constructed in Zomba and filled with 130 tons of maize. Covering and sealing was complete by November 18th. The carbon dioxide concentration of the inter-granular air at 2 ft., 8 ft., and 12 ft. below the surface was estimated four days after sealing the pit and at seven day intervals thereafter. Up to 46 days after sealing (the time of writing) the carbon-dioxide concentration showed a regular fall from an average of 9.9 to 4.3 per cent. A slight increase in the carbon dioxide concentration from 2 to 12 ft. was maintained during the period of observation.

Grain temperatures were recorded twice weekly at the 2 ft., 8 ft., and 12 ft. levels. At 8 ft. there was a steady fall in the grain temperatures from 95°F at four days to 89°F at 39 days, and at 12 ft. the fall over the same period was from 90 to 83°F. From 39 days to the time of writing the temperatures at both these levels remained constant. At 2 ft. below the surface, however, grain temperatures showed a fluctuation extending over a range of 14°F which bore relation to the changes in air temperatures.

It was expected that the infestation in the maize, which averaged 6 *Calandra oryzae* per 500 gms., would under the gas-tight conditions thought to obtain, raise the CO_2 in the inter-granular air to above 10 per cent. at which concentration insect activity in the grain would be inhibited. Minute examination of the above-ground portion of the roofing-felt cover of the pit failed to reveal any possible site of air-leakage, and it is difficult to suggest the reason for the CO_2 fall, except possibly diffusion caused by the fluctuation of grain surface temperatures. In order to reduce this fluctuation the roofing-felt was covered with 6 ins. of soil and then turfed.

Locusts

106. No Locusts in any stage of development were reported from the Protectorate during the year.

The Insect Collection

107. Four consignments of insects were submitted to the Commonwealth Institute of Entomology for identification and 49 named specimens added to the Insect Collection.

Acknowledgements and References

108. My thanks are due to the Commonwealth Institute of Entomology, for the identification of insect specimens and to the Pest Infestation Laboratory, Slough, for much advice in matters of Stored Products Entomology.

DIVISION OF ECOLOGIST

Ecologist in Charge .. .. G. Jackson

Preliminary survey

109. A preliminary survey has been attempted in districts of the Northern, Central, and Southern Provinces by means of road transect surveys and a tentative classification of main communities made. The grass flora has not been studied as yet in great specific detail ; from July onwards the grass inflorescences did not afford sufficient material for identification down to the species, although one was able to give the generic named in many instances. The aspect of the grassland was, however, apparent and the following types were classified :

(*a*) *Bunch grass communities* to be found in woodlands throughout the country. Practically without exception all the genera found are tussock-forming and as a result the ground cover is low. The grasses become coarse after flowering and in July appear to give little nutritive fodder.

(*b*) Arising directly out of the above are the *annual grass communities* which come about as the result of native agricultural practices and grazing. Scrub communities of varying botanical composition become established and the direct result is the deterioration of the original sward to one of annuals.

(*c*) *Swamp grazings* in country which includes the above two groups. They are located in areas of seasonal or perennial waterlogging, generally shallow depressions in the usually flat topography. The cover appears dense but this is probably due to the fact that it is well dispersed.

(*d*) *Flood plain grasslands* of the Lake-shore and Shire Valley. These vary in composition according to soils and water table. They are tall growing grasslands and quite dense. Under cultivation and reversion to grass, the main grass found is *Urochloa sp.* and this affords much grazing in the Lower River District.

(*e*) *Mountain grasslands.* These are found in areas over 4,000 ft. arising as the result of the destruction of forest growth by burning. This is a well dispersed grass community and on the Kirk Range appears to maintain the cattle in reasonable condition in the dry season.

(*f*) *Artificial grasslands* mainly *Cynodon dactylon* swards around dipping tanks and in certain areas near Blantyre and in the Livulezi Villey.

Herbarium

110. A Herbarium has been started at the Research Station and now has a total number of 204 named specimens, many of which were duplicates transferred from the Plant Pathologist's Herbarium.

In addition to this material a further 340 specimens have been collected of which 13 have been named by consulting the Herbarium whilst the rest await accurate determination from Kew.

Nurseries and Grass Trials

111. Several Colonies and Dominions have sent samples of seed to the Station for trial on a nursery scale and for multiplication. These include the hairless Napier Fodder from Uganda and Gold Coast Napier from South Africa, the latter sets fertile seed and is almost hairless.

Of indigenous grasses, two have been propagated as they look promising. One, an unidentified grass from Chia, has a creeping habit and under nursery conditions at least, spreads rapidly and thickly. *Cynodon Kotakota*, the grass found actually in the native town, is vigorous and grows rapidly and will probably be useful on worn out lands for the establishment of permanent pastures.

A start was made in establishing grass nurseries and the following species were planted :

TABLE 36

PLANTED FROM SEED—JANUARY	PLANTED FROM ROOTS—DECEMBER
Paspalum notatum	*Panicum sp. Makarikari*
Paspalum dilatatum	*Paspalum dilatatum*
Cenchrus ciliaris	*Cynodon No. 2*
Eragrostis curvula	*Vetiveria*
Paspalum urvellei	*Paspalum notatum*
Rhodes grass (Chloris gayana)	*Seychelles*
Gugu (Sorghum verticilliflorum)	*Digitaria—Water val strain*
Kentucky 31	*Cenchrus ciliaris*
	Acrocerus macrum

PLANTED AFTER RAINS

Digitaria swazilandensis
Paspalum urvellei
Eleusine (local)
Chloris (local)

The grasses in the 1950 nurseries showing most promise are *Panicum makarikari* and *Cynodon No. 2*. The *Paspalums* are most disappointing, none of them making good growth or cover. *Cenchrus ciliaris* made a good stand but appeared to be unpalatable to cattle.

It is proposed next year to extend these trials to the swamp grazing area and to see if the performances of the *Paspalums* can be improved when there is more moisture available.

H. GILLMAN
Acting Director of Agriculture